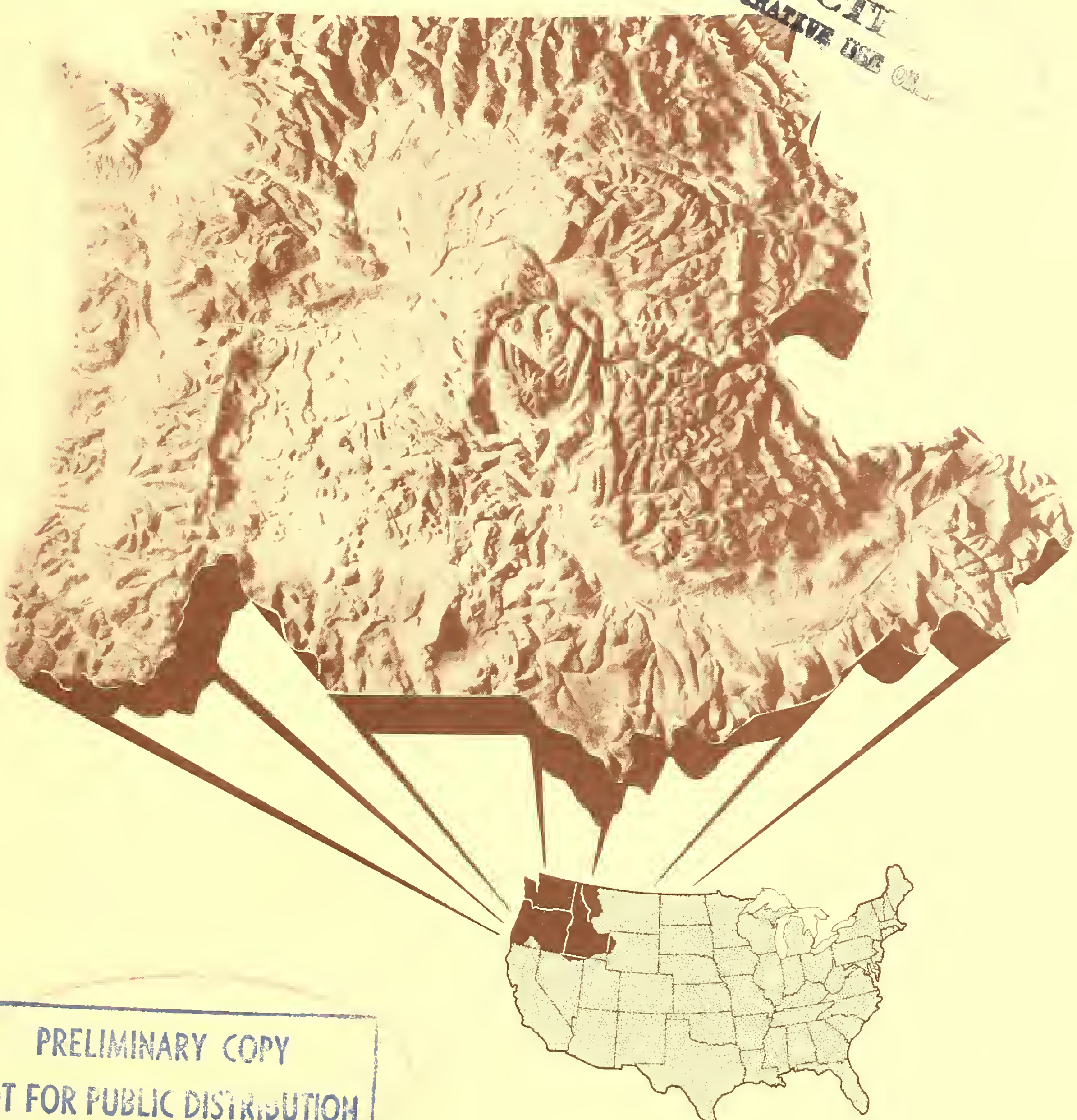
Summary Report

COLUMBIA RIVER BASIN AREA AGRICULTURAL PROGRAM



U.S. DEPARTMENT OF AGRICULTURE

SUMMARY REPORT

COLUMBIA RIVER BASIN AREA
AGRICULTURAL PROGRAM

UNITED STATES DEPARTMENT OF AGRICULTURE

October 1953

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INTRODUCTION

The Department of Agriculture, with cooperation of other Federal, State and local agencies, has prepared a general long-range plan for a multiple purpose agricultural program for the Columbia River Basin area. This plan is presented in the report that follows. The basis for this plan was an inventory of the watershed land and water work that needs to be done irrespective of land ownership. Under this plan the programs and activities of the Department, as well as those of other land administering agencies which relate directly to the development, utilization, and conservation of land and allied resources have been integrated into a unified land and water program.

This agricultural program is designed primarily to: Conserve and improve the lands and increase their productivity; protect, utilize, and increase the productivity of the forest and range resources; protect, enhance, develop, and use the water resource; improve the use of land and water through improved farm irrigation and drainage; reduce upstream flood water and sediment damages; protect and improve recreation facilities and encourage development and maintenance of appropriate wildlife populations. This program will complement the major structural programs for the development and utilization of the area's water resources which are planned and under construction.

The needs of the watersheds in the area for special measures for waterflow retardation and the prevention of soil erosion in aid of flood prevention are shown. The unique feature of the plan is the systematic coordination of the many and diversified services of the

Department and other public land administering agencies into an integrated program of proper land and water use. The plan contemplates acceleration and adaptation of activities and services which have been traditionally administered in accordance with inflexible nation-wide patterns and suggests these various needed activities and services be provided in amounts consistent with the specific needs of the area.

A large potential for future resource developments is one of the distinguishing characteristics of the Columbia Basin area. If future food and fibre needs are to be met, without damage to basic resources, patterns of development should be adapted which will assure continued productivity and improvement of the area's soil, water and allied resources. The present need for a plan is acute because of the rapid rate of economic growth which is occurring in this region.

DESCRIPTION OF THE COLUMBIA RIVER BASIN AREA

Location and Size

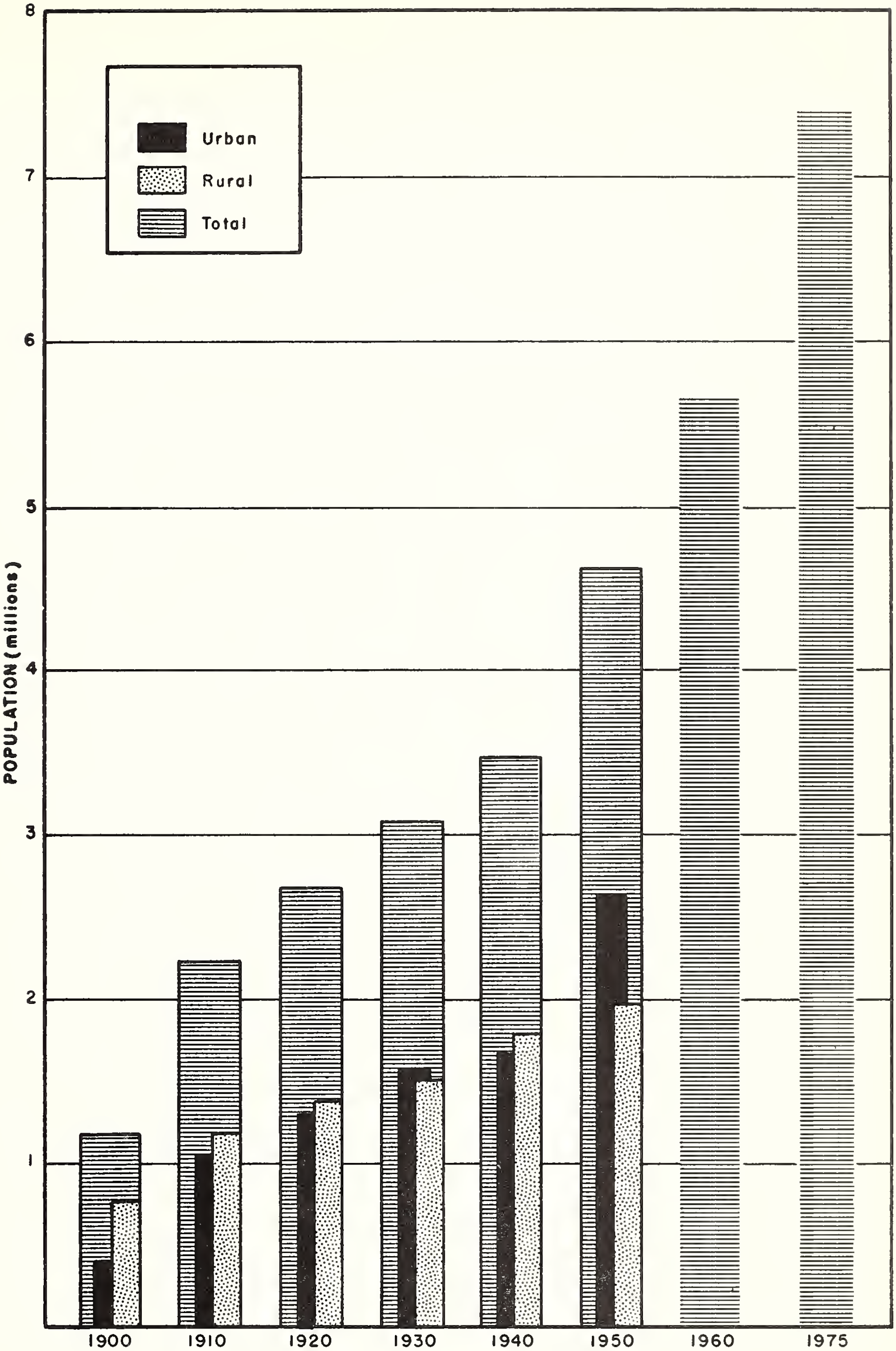
The Columbia River Basin area as used in this report occupies 175 million acres in the northwestern corner of the United States (Fig. 1). It includes all of the State of Washington, most of Oregon and Idaho, western Montana, and small parts of Wyoming, Utah, Nevada, and California. In northern Montana, a small part of the St. Marys River drainage tributary to Hudson Bay is also included.

On the east the area is bounded by the Continental Divide in the Rocky Mountains, on the north by the Canadian border, and on the west by the Pacific Ocean. On the south the boundary approximates the southern rim of the Snake River, Harney Basin, Rogue River, and Chetco River watersheds. Some 23 million acres of the Columbia River drainage which are in Canada are not covered in this report.

Population

The total population of the Columbia River Basin area has grown from 1,174,000 in 1900 to over 4,614,000 in 1950, an increase of almost 300 percent in 50 years. Present population trends indicate that a population of approximately 5,650,000 can be expected by 1960 and of 7,367,000 by 1975 (Fig. 2).

The rate of increase is greater than for the entire nation. Total population in the Basin area increased by 33 percent from 1940 to 1950, while during the previous decade the increase had been only 13 percent. The increase from 1940 to 1950 had been attributed to many factors, but probably the most important were the war-created



Population trends in Columbia River Basin Area with projections to 1975

Figure 2

defense activities and the resulting demand for labor. With the end of the war people shifted into non-defense activities and remained in the area.

The increase in population has been to a large extent at the expense of other areas. In both Washington and Oregon total migration into the state during the 1940-50 decade was greater than the excess of births over deaths.

Population is concentrated primarily in the area west of the Cascades and in the irrigated valleys in the interior (Fig. 3). The density of population ranges from an average of one person per square mile in the Harney Basin-Owyhee area to 63 persons per square mile in the Willamette Valley. For the entire basin there is an average of 17 persons per square mile.

The four largest cities, Seattle, Portland, Spokane, and Tacoma, have one-fourth of the total population of the entire Columbia River Basin Area. The cities with populations of 25,000 or more are listed in Table 1. In addition there are 31 cities with 10 to 25 thousand.

In 1950, only 43 percent of the population was classified as rural. It is estimated that between 1940 and 1950, urban population increased by 37 percent while rural population increased by 30 percent. Although almost 2 million persons were included in the rural population, only 683 thousand of these, or approximately one-third, live on farms. The rural farm population represents less than 15 percent of the total population.

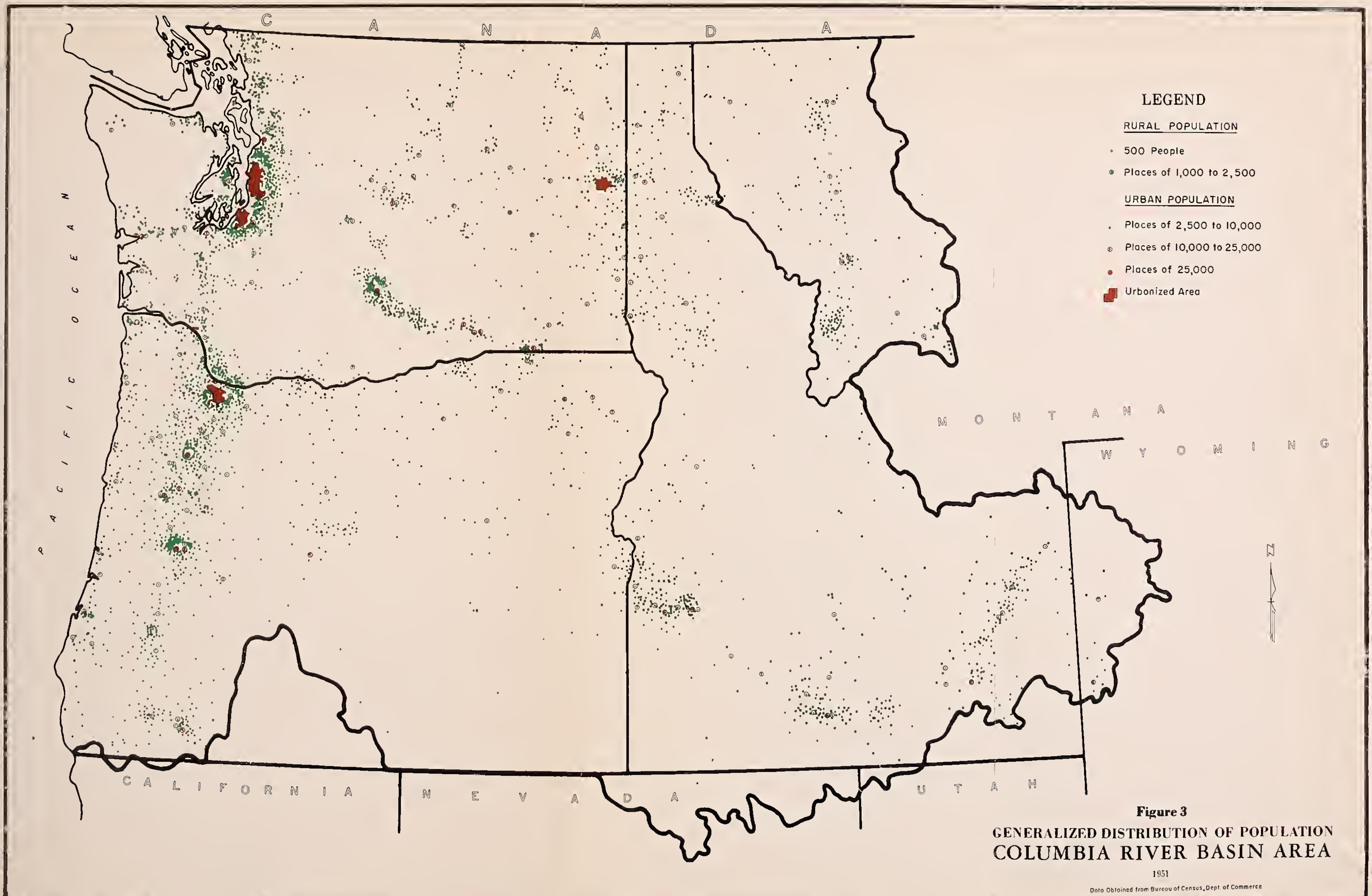


Figure 3

GENERALIZED DISTRIBUTION OF POPULATION

COLUMBIA RIVER BASIN AREA

1951

Data Obtained from Bureau of Census, Dept. of Commerce

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Table 1.--Population of Major Cities of the Columbia River Basin Area, 1950.

City	Population (thousands)	City	Population (Thousands)
Seattle, Washington	468	Eugene, Oregon	36
Portland, Oregon	374	Boise, Idaho	34
Spokane, Washington	162	Everett, Washington	34
Tacoma, Washington	144	Bellingham, Washington	34
Salem, Oregon	43	Butte, Montana	33
Vancouver, Washington	42	Bremerton, Washington	28
Yakima, Washington	38	Pocatello, Idaho	26

Physiography

The Columbia River Basin Area is composed of several rather distinct physiographic provinces (Fig. 4). At the western edge is the Coast Range province, running north-south along the Oregon and Washington coast and including the Coast Range in Oregon and the Willapa Hills and Olympic Mountains in Washington. To the south, the Coast Range rises abruptly from sea level to a height of 5,000 feet or more. At the extreme northern end, the peaks of the Olympics rise to 8,000 feet. Most of the drainage from these coastal mountains is by short rivers running west to the Pacific Ocean. At its southern end, the Coast Range meets the cross ranges of the Siskiyous which extend east to the Cascades and provide part of the southern boundary of the Basin.

East of the Coast Range province and parallel to it is the

Figure 4
PHYSIOGRAPHIC PROVINCES
COLUMBIA RIVER BASIN AREA

1951

Relief Map by Bonneville Power Administration

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Puget Sound-Willamette trough. This province lies below 1,000 feet elevation and is composed of alluvial materials brought in by ancient glaciers and by present day streams from the Cascade Range to the east, and the Coast Range to the west. It is 30 to 50 miles wide and about 350 miles long. The Willamette River in Oregon drains the southern half of the province, emptying into the Columbia River. The Lewis and Cowlitz rivers which are tributary to the Columbia, the Chehalis River flowing to the ocean, and the Skagit River and numerous streams emptying into Puget Sound drain the northern part.

The Cascade Mountains, the dominant feature of the western part of the Columbia Basin, form the third province. This mountain block runs north-south, parallel to the two provinces just described. The main mass lies at about 5,000 feet elevation. Several volcanic peaks above 10,000 feet are included, with Mt. Rainier, at more than 14,000 feet, the highest. Except for the narrow gorge out by the Columbia River, this long mountain range sharply separates the coastal from the interior portions of the Basin. It has a strong influence on the climate.

Immediately east of the Cascades in northern Washington is the Okanogan Highlands province. It is composed of a series of north-south mountain ranges with peaks reaching from 5,000 to 7,000 feet elevation. The Spokane and Columbia Rivers mark the southern edge of this province which is drained by the Okanogan, Sanpoil, Kettle, and Colville Rivers.

The Columbia Plateau is the central province of the Basin. From elevations of 4,000 feet around the edges, it slopes gently down to

less than 1,000 feet approaching the gorges of the Columbia and the lower Snake River. The surface of the plateau appears flat to gently rolling, but is dissected by the channels of present-day streams and in the northern part by deep coulees which are former channels of the ancient Columbia. The plateau extends from the upper curve of the Columbia south to the Blue Mountains in Oregon, east to the Rocky Mountains in northern Idaho, and west to the Cascades. It is drained by several small rivers tributary to the middle Columbia and to the lower Snake.

The Ochoco-Blue-Wallowa Mountains province lies in northeastern and central Oregon and in extreme southeastern Washington. Peaks in this mountain block reach elevations of 7,000 to 10,000 feet. The area is drained by the John Day, Crooked, Umatilla, and Walla Walla Rivers flowing to the Columbia, and by the Grande Ronde, Malheur, Imnaha, Powder, and Burnt Rivers and other smaller streams tributary to the Snake.

Southernmost of the central provinces, the Harney Basin occupies a high plain dotted with volcanic cones and broken by fault-block troughs and short mountain ranges. This province extends across south-central Oregon from the Cascades almost to the Idaho border. The general base level is 4,000 feet, and the peaks reach from 6,000 to 9,000 feet. Small parts of the area are drained by the Owyhee and Malheur Rivers to the Snake, but most of the drainage is by small intermittent streams that disappear on the flat plain or empty into lakes which have no outlet.

To the east is the broad Snake River Plain, extending from

southeastern Oregon across southern Idaho. The low mountain ranges of northern Nevada and northwestern Utah are included in the province, and form the southern boundary of the Columbia Basin. Elevations range from 3,000 feet along the Snake River to more than 10,000 feet on the peaks. The eastern and northern edges of the area lie against the ranges of the Rocky Mountains. Major drainages are those of the Owyhee, Bruneau, and Big Wood Rivers tributary to the Snake.

The Rocky Mountain province is the largest, and lies on the eastern edge of the Basin. It occupies western Montana, western Wyoming, and most of central and northern Idaho. It is composed of a series of mountain ranges generally oriented north to south. Between the ranges are narrow steep-walled valleys in which the major streams of the area flow. A few of the rivers have broad flat valley sections. Elevations vary from 3,000 feet in the lowermost valleys on the west to more than 10,000 feet on many of the peaks. The southern and western part of the province are drained by the Snake and its principal tributaries, the Boise, Payette, Weiser, Salmon, and Clearwater Rivers. The northern part drains to the Columbia in Canada through the Clarks Fork and the Kootenai Rivers. In the northwest part, the Spokane River drains a considerable area to the middle Columbia.

Climate

West of the crest of the Cascade Mountains, a temperate humid maritime climate prevails. Summers are dry and moderately warm; winters are wet and mild. Extremes of heat and cold and destructive storms such as tornadoes are rare. Topographic patterns determine climate. the valleys are warmest and driest, the mountains are cold-

est and wettest. Above 5,000 feet elevation most of the precipitation comes as snow.

East of the Cascade crest in the central provinces, the climate is arid to semi-arid, with greater extremes of temperature both summer and winter. Low humidities and great amounts of sunshine characterize the area. While the climate is continental, it is modified by winds from the Pacific Ocean.

In the eastern part the climate becomes more definitely continental, with summer rainfallfrom small localized storms. However, the climate is fairly dry. Temperature extremes are great, but excessively hot or cold spells are of short duration. The Snake River Plain province is much drier than the higher Rocky Mountains area.

Precipitation

Two factors control the precipitation pattern. One is nearness to the moisture supply (the Pacific Ocean) and the other is elevation. For the same elevation, the western parts receive the greatest precipitation. For the same distance from the ocean, the higher mountains receive more than the plateaus and valleys (Fig. 5)

The heaviest precipitation in the United States occurs along the western slopes of the Coast Ranges and is estimated to reach over 200 inches annually in the Olympic Mountains. From the crest of the coastal mountains, precipitation decreases to about 35 inches in the Puget Sound-Willamette area, then rises again to 100 inches toward the crest of the Cascades. Here, heavy snowpacks have formed glaciers on many of the higher peaks. The variations in annual precipitation range from 60 percent to 150 percent of the average.

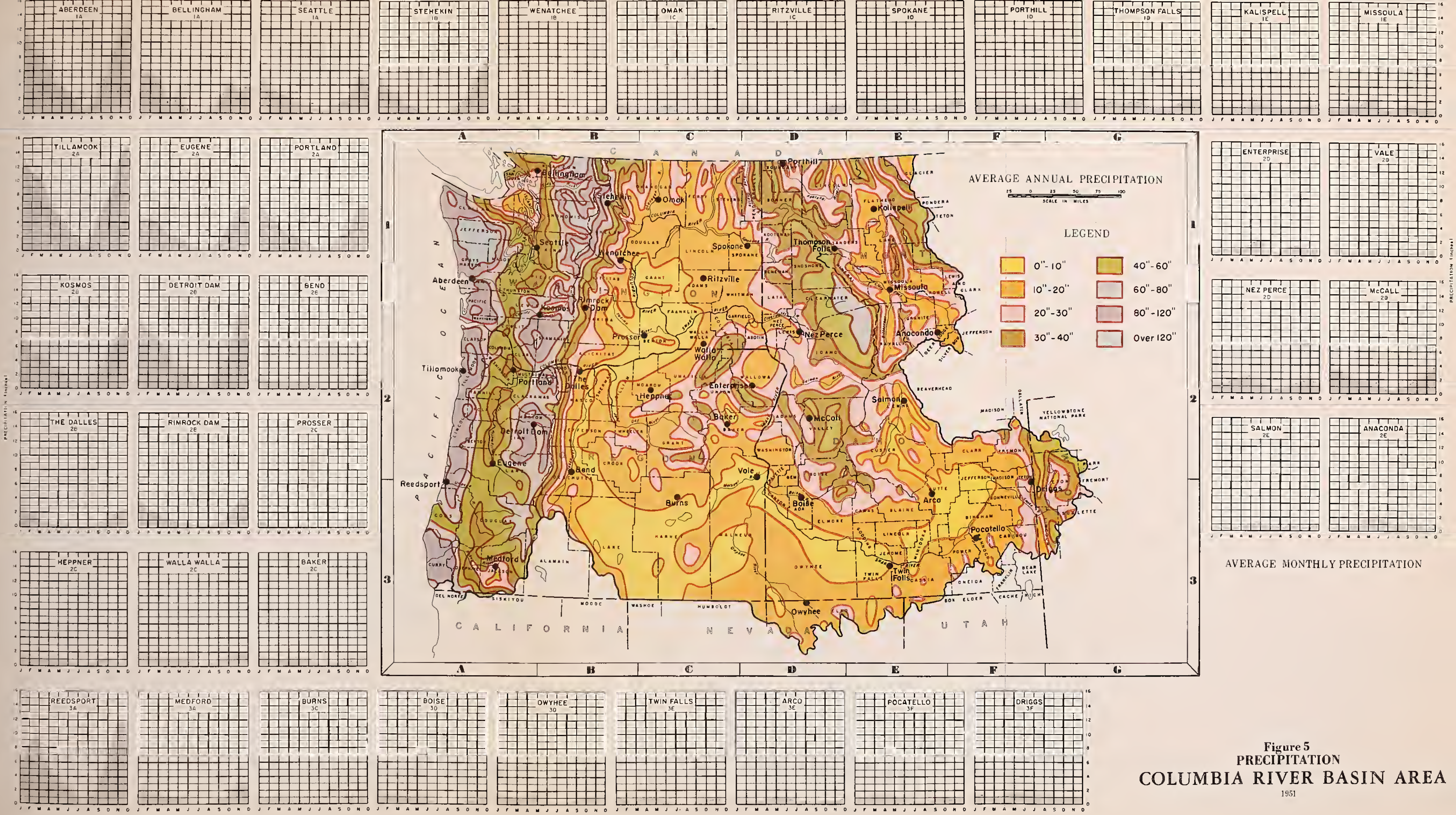

Figure 5
PRECIPITATION
COLUMBIA RIVER BASIN AREA
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Intensities rarely reach one inch in one hour, though several rainfalls from six to twelve inches in 24 hours have been recorded.

East of the Cascade Mountains, precipitation decreases rapidly to ten inches or less in the valleys and on the plateaus. Mountain areas of the central provinces receive 40 to 50 inches, much of it as snow. Spring and summer cloudburst storms are fairly common, and rainfall intensities often reach more than an inch an hour. Variation in annual precipitation ranges from 50 to 165 percent of the average.

The Snake River Plain receives from six to fifteen inches of precipitation, and the Rocky Mountain province from 10 to 70 inches annually. Both mid-winter and late-spring peaks characterize the pattern. Extensive snowfields formed in the mountains in winter are the principal source of water for the streams of the region. Rainfall intensities as high as two inches per hour have been recorded and occasionally cause severe erosion and flash floods. Year to year variation in precipitation is similar to that of the central provinces.

Storms of two types occur throughout the Basin area. Winter storms are widespread; they bring the long rains that characterize coastal areas and the heavy snows that build deep snowpacks in the mountains. They occur from fall to early spring and may last from four to nine days. Summer storms are of short duration and affect much smaller areas. They may be accompanied by hail and strong winds that damage growing crops.

If dry periods be defined as those of one month or more with less than one-half inch rainfall per month, the part of the Basin

west of the Cascades suffers little. Along the coast, dry months occur nearly every year, but two-month periods occur only about once in ten years. In the Willamette-Puget Sound area, two-month dry periods occur once in three years, and three-month dry periods about once in ten years. Dryness here is generally more pronounced to the south. The central provinces have two-month or three-month dry periods nearly every year, and of four to six months' length from once in four to once in ten years. The eastern provinces are similar, with the mountain areas more humid than the plateaus and larger valleys. Dry summers are normal, but the occasional dry spring and fall seasons affect crop production adversely.

Annual variation in precipitation also is a matter of concern. Dry years with less than two-thirds the average precipitation occur about once in 30 years along the coast and in the Cascades, about once in 20 years in the Willamette-Puget Sound and Rocky Mountain provinces, once in 15 years in the central provinces, and once in 5 years in the Snake River area. Dry years may come in groups; the period 1928-30 was abnormally dry over most of the Columbia Basin. In contrast, the period 1948-50 was abnormally wet.

Temperature

West of the Cascades, temperatures in the lower areas range from a January average of 36° F. to a July average of 62° F. The frost-free season is 200 to 240 days long, from April to November. Daily variations are about 15° F. in winter and 20° F to 25° F. in summer. Extremes above 100° F. or below 10° F. are rare.

In the central provinces the January average temperature is from

20° F. to 30° F., and the July average from 60° F. to 75° F. Daily range in winter is from 15° F. to 30° F., and in summer from 30° F. to 50° F. Extremes well above 100° F. and below -20° F. are common. Depending on elevation, the frost-free growing season varies from less than 100 days in the high plateaus to 200 days in the lowest valleys.

The easternmost provinces have similar temperature conditions, but slightly more severe. January average temperature is from 15° F. to 30° F., and the July average from 55° F. to 75° F. Extremes of 120° F. to -60° F. have been recorded. The frost-free growing season varies from 80 days in the mountain valleys to 180 days in the western part of the Snake River Plain (Fig. 6).

<u>Other Climatic Elements</u>

Wind storms occasionally do damage to timber stands, agricultural lands and crops, public utilities, buildings, and industrial developments. Cold winds from the north and east bring mid-winter periods of freezing weather, while warm winds from the west and south accompany fall and winter storms. Hot dry winds from the east in summer cause humidities to drop and bring on conditions of extreme forest fire danger. Wind velocities average from four to sixteen miles per hour over the Basin. Extremes over 100 miles per hour have been recorded along the coast. Prevailing wind movement is from the west.

Mountain snowpacks reach their greatest depth in March or April, and the general melt period begins a little later. Warm winds are a factor in the general snowmelt. Snowmelt runoff is greatest late

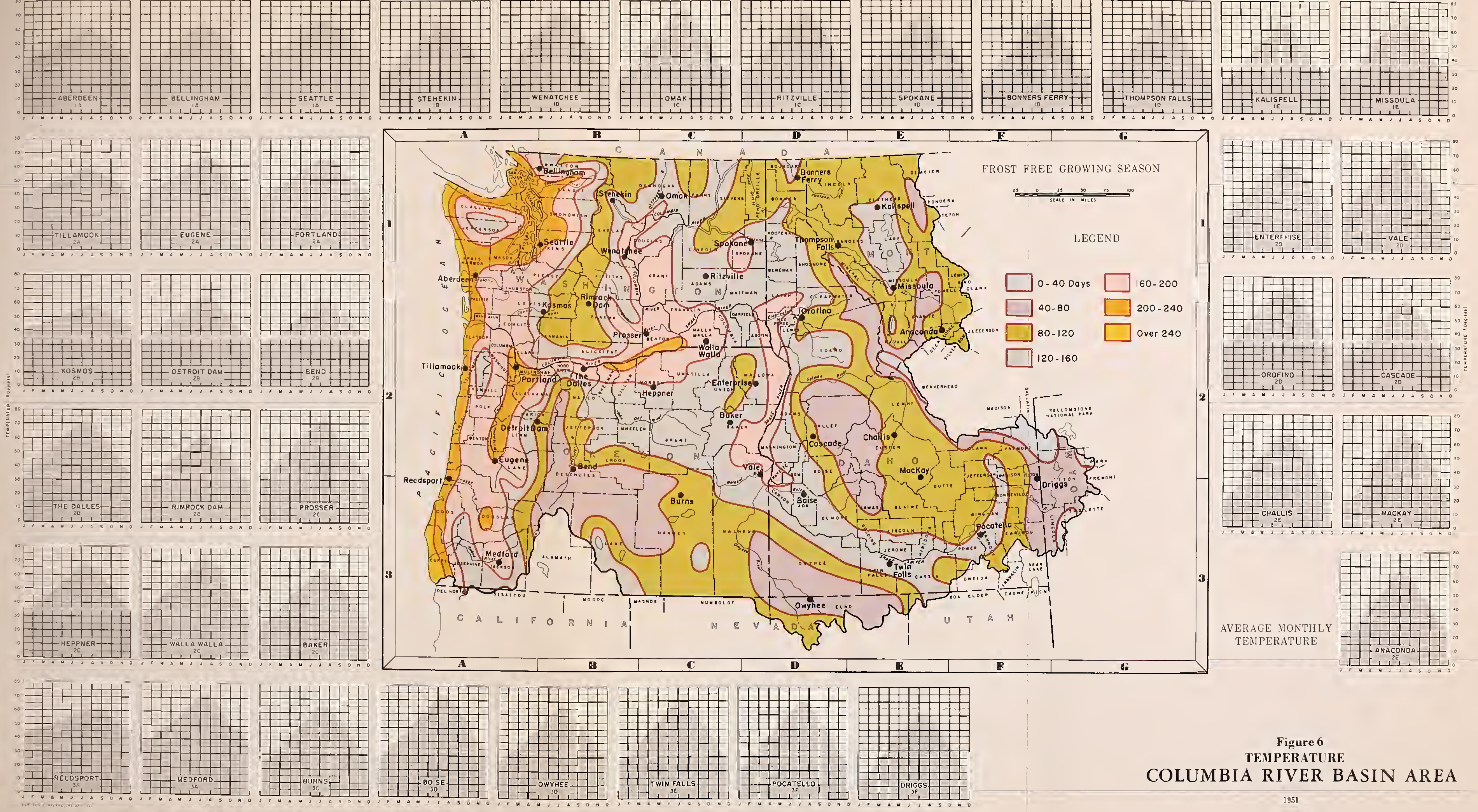

Figure 6
TEMPERATURE
COLUMBIA RIVER BASIN AREA

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in May or early in June. Normally, spring flood peaks in the Columbia River occur the first week in June. Mid-winter thaws in January and February often melt much of the snow at lower elevations and cause local flooding.

Evaporation is a factor of significance to agriculture. Mid-summer water losses in the interior provinces from eight to twelve inches per month have been observed at many places. West of the Cascades, highest losses are usually less than seven inches per month. High rates occur where the growing season is warm and windy. Under such conditions, rates of transpiration loss from plants are high.

Water Resources

The water resources of the Columbia River Basin Area are among its greatest assets. The large amount of water readily available for irrigation, electric power generation, industrial and domestic use, and for other purposes, has been and will continue to be a significant factor in the development of the area. The volume of flow of the Columbia River itself is exceeded in the United States only by that of the entire Mississippi River system.

Water Use

There are over 4 million acres of cropland under irrigation, and the Bureau of Reclamation estimates that nearly 4 million acres more can be irrigated. On range lands, availability of water is one of the important factors determining livestock distribution. Industrial development is contingent on availability of water, both as a raw material and for use in manufacturing processes. The large vol-

ume of water and the steep gradient of the river help to make the Columbia River the largest present producer and greatest potential source of hydroelectric power in the United States. Electric power is an extremely important factor in enabling farmers of this area to compete successfully with those closer to markets. Community existence and growth also depend on the presence of water. Recreation is in good measure tied to the location of water. The Columbia River and certain of its tributaries are the primary salmon-producing waters of the United States. Navigation on the larger waterways is important to commerce. All of these uses are built upon availability, dependability, and quality of the water supplies of the area. The water yield is vitally important.

Streamflow

Yields of the streams vary widely. Yields of some of the principal streams are shown in Table 2. Seasonal variation in flow is high. In the driest years, flows of the larger streams may average only 20 percent of the mean annual flow; in the wettest years, more than twice the mean. Seasonal extremes range from no flow in some streams to more than 20 times the mean. In the milder coastal climates the range in yields is much narrower than in the more arid interior provinces. West of the Cascades stream flow is usually high from October or November to April or May, dropping sharply during the dry summer. Eastward, stream flow is high from March through July and is usually lowest in mid-winter. Many streams are deficient in flow to meet needs for part of each year, and storage of excess winter and spring stream flow is necessary to increase the total

usable yield. Sites are still available for providing additional storage for future power and irrigation development and other uses.

Contributions from different physiographic provinces and different classes of land vary tremendously. In the Coast Ranges, the Willamette-Puget Sound trough, and the Cascade Mountains where the total precipitation is greatest, there are huge seasonal water surpluses. Eastward, the Okanogan Highlands and Rocky Mountain provinces produce significant volumes as river flow. The snowpack, caught and held in the upper watersheds, including those in Canada, furnishes the bulk of flow in the Columbia River. To the southeast much of the flow of the Snake River comes from the high mountain fringes which constitute but a relatively small part of that watershed. The Columbia Plateau, Harney Basin, and Snake River Plains receive limited precipitation and do not contribute much to total water yield.

Ground Water

Ground water is widely used for municipal water supplies, in industry, and as a source of domestic, livestock, and irrigation water. Unlike stream flow or surface water, ground water is generally more uniform in quantity, chemical quality, temperature, and other characteristics. Although ground water is intensively developed in a few small areas, the ground water resource has not been fully explored over more than 5 percent of the Basin area. The Puget Sound-Willamette Trough area, lying between the coast and Cascade mountain ranges in Oregon and Washington, has several proven ground water basins and geological conditions that provide ground water over most of the area. Potentials of ground water development in the

Table 2 - Water Yield of Representative Drainage Areas, Columbia River Basin Area

River	Drainage area	Average Annual Yield: Depth on Watershed	Average Annual Yield: Volume	Extreme Annual Yield: Minimum	Extreme Annual Yield: Maximum
	Sq.Mi.	Inches	1000 Ac. Ft.	% of average	% of average
Western Washington					
Skagit	2,970	74	11,700	63	121
Puyallup	914	48	2,320	65	154
Chehalis	897	38	1,830	62	143
Lewis	731	82	3,210	65	156
Quinault	264	137	1,940	66	136
Eastern Washington					
Wenatchee	591	50	1,590	58	152
Yakima	3,560	15	2,780	47	164
Colville	969	5	163	31	218
Spokane	4,350	22	5,010	36	150
Palouse	2,210	3	353	33	212
Northern Idaho					
Coeur d'Alene	1,220	26	1,689	45	166
Clearwater	9,570	20	10,439	60	
Western Montana					
Clark Fork	10,500	9	5,190	50	163
Flathead	6,990	21	8,071	47	155
Kootenai	13,700	14	10,479	57	150
Western Oregon					
Rogue	2,020	18	1,982	42	160
Coquille (S. Fk.)	169	57	520	55	183
Umpqua	3,680	26	5,106	45	159
Siletz	202	106	1,142	63	141
McKenzie	930	53	2,636	68	146
Willamette	7,280	41	15,670	63	163
Eastern Oregon					
Deschutes	10,500	8	4,210	72	135
John Day	7,580	3	1,365	34	196
Owyhee	10,400	1	617	25	152
Umatilla	2,290	3	365	34	221
Grand Ronde	2,555	10	1,422	62	165
Southern Idaho					
Salmon	13,550	6	7,546	56	143
Boise	2,220	14	1,630	51	153
Bruneau	2,640	2	302	94	133
Snake	35,800	4	7,654	66	143
Big Wood	640	9	297	17	149
Henrys Fork	660	20	716	73	131
Columbia River at The Dalles	237,000	11	140,637	61	160

Columbia Plateau are rather large with the advent of present modern drilling equipment, low cost electric power, and efficient deep well pumps. Water found in the area is generally of good quality for nearly all purposes. The presence of large springs in the Snake River Plain, together with records of wells scattered over much of the area, are indicative of large ground water resources in the plain and adjacent foothill areas. However, over much of the area, depths to adequate amounts of ground water are several hundred feet. Extensive ground water development is now underway in various parts of the Snake River Plain.

Soils and Geology

The rock formations of the Columbia River Basin area are varied and mixed. The western coastal mountains are composed of old sedimentary sandstones, metamorphosed slates and schists, deeply weathered intrusive granite rocks, and old volcanic rocks. The Cascade ranges are primarily volcanic basalts and andesites, with granitic and metamorphic rocks at the northern end. The Puget Sound area and many valleys of northeast Washington and northern Idaho have been filled with glacial debris scoured from the mountains. The central and southern provinces are underlain by vast areas of more recent volcanic basalts. The belt of granitic rocks extends across the Okanogan Highlands area and into Central Idaho. At the western end of the Snake River Plain is a large area of old lakebed deposits, and a belt of deep wind-deposited material covers the eastern and southern half of the Columbia Plateau. The Rocky Mountains are made up primarily of sedimentary and metamorphic rocks, with the valleys between

the ranges filled with alluvial material.

The great variety in the parent rocks has had a strong effect on soil development (Fig. 7). In the coastal areas, on the sedimentary and metamorphic rocks, the soils are heavy in texture and quite acid. The gravelly glacial drift of the Puget Sound region has developed lighter-textured soils. In the Willamette Valley the alluvial soils are of medium to heavy texture, with heavy clay residual soils developed from the underlying volcanic rocks on the hills and benches around the valley. The high rainfall belt of the Cascades has medium to light-textures "shot" loam soils on the basalts and heavy loams with clay subsoils on other volcanic formations.

The granites and sedimentary rocks east of the Cascades have developed sandy loams that are readily eroded when exposed to wind and water. The lakebed and wind-deposited soils of the central portion of the basin range from silt loams to clay loams; these, too, are easily eroded. Metamorphosed rocks of the Rocky Mountain province have developed soils generally medium in texture and fairly stable. Heavy textured soils are found on the finer-grained sedimentary rocks. The lavas of the Snake River Plain support medium-textured loam soils with heavy subsoils, again quite erodible. Soils derived from other formations of the area cover a wide range of textures and fertility, and nearly all are rather highly erodible.

The alluvial soils of the valleys, and the wind-deposited soils of the Columbia Plateau and Snake River Plain are the best for agriculture, being quite fertile. The majority of the wheat crop of the interior portion of the Basin is grown on the wind-deposited soils,

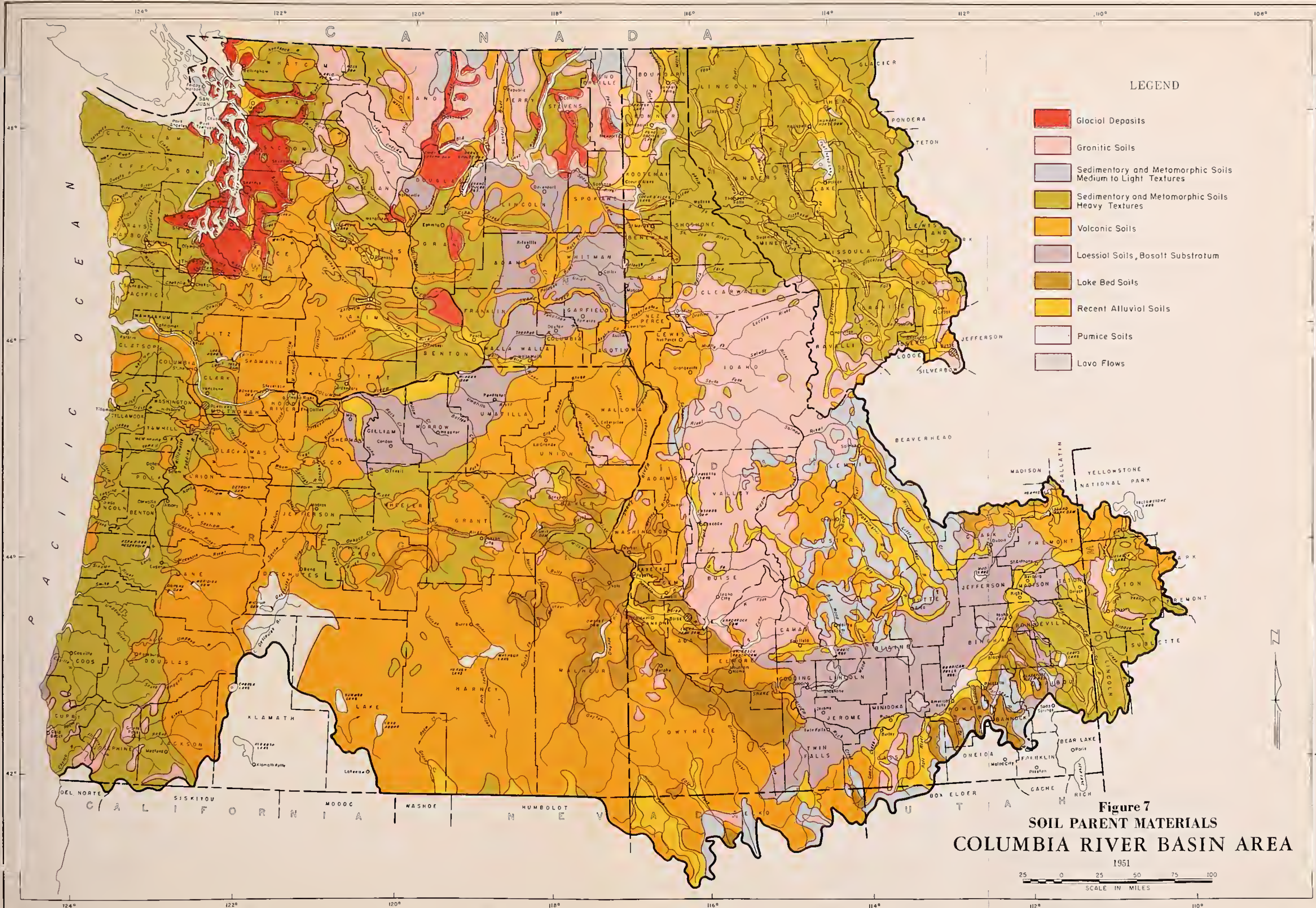

Figure 7
SOIL PARENT MATERIALS
COLUMBIA RIVER BASIN AREA
1951

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while the alluvial soils are the basis for an intensive irrigated agriculture.

Land Capability

Land capability is the inherent ability of the land to produce permanently under specified uses and treatments. Land capability classification is based principally on physical characteristics of slope, soil depth and texture, but also includes climatic limitations. In this classification the best land is that which will allow the most intensive cultivation and require the least in special management and treatment practices. Conversely, the poorest land is that which is most restricted in its use and requires the most in special management and treatment practices.

The classification provides for eight classes of land to indicate the intensity of conservation problems and the maximum feasible intensity of use and four subclasses to indicate the dominant problems - erosion hazard, wetness, soil deficiency, or climatic limitation. Classes I, II, III, and IV include lands suitable for cultivation. Classes V, VI, and VII include lands not suitable for cultivation but are suitable for permanent vegetation, either range or woodland. Class VIII includes lands not suitable for cultivation or the production of harvestable forage or woodland products, but suitable for wildlife, recreation, or watershed (Fig. 8 and Table 3).

Land Suitable for Cultivation

Class I land is very good land which has deep soil, is nearly level and has no serious hazards or limitations. It needs practices to maintain soil fertility, soil tilth, and moisture intake capacity.

It includes well-drained bottoms and associated bench lands along rivers and streams and very gently sloping or nearly flat plateaus having deep loamy soils.

Class II land is good land that can be cultivated safely with easily applied conservation measures. It is subject to moderate limitations in use or risks of damage because of gentle slopes, moderate susceptibility to erosion, moderate soil depth, somewhat unfavorable soil texture and workability, moderate wetness correctible by drainage, slight concentration of toxic salts, or minor soil deficiencies. These lands include nearly level first bottoms and higher benches along rivers and streams, ancient lake bottoms and terraces, and some gently sloping lands.

Class III land is moderately good land that can be used for crops in a good rotation. It requires intensive application of conservation practices. It is subject to severe limitations because of moderate slopes, high susceptibility to erosion, continuing hazard of excessive wetness, shallow soil, low moisture holding capacity, severe alkalinity or salinity, or low inherent fertility. Most of this land is located on moderately steep slopes of the Palouse and Blue Mountain area and the summer fallow wheat area of central Washington, northern Oregon and southeastern Idaho. It includes also the land with moderate slopes and soil limitations in the irrigated areas, the wet bottom lands subject to overflow, and the moderately sloping hill lands of the Pacific slope and other subhumid areas.

Class IV land is fairly good land that is best maintained in

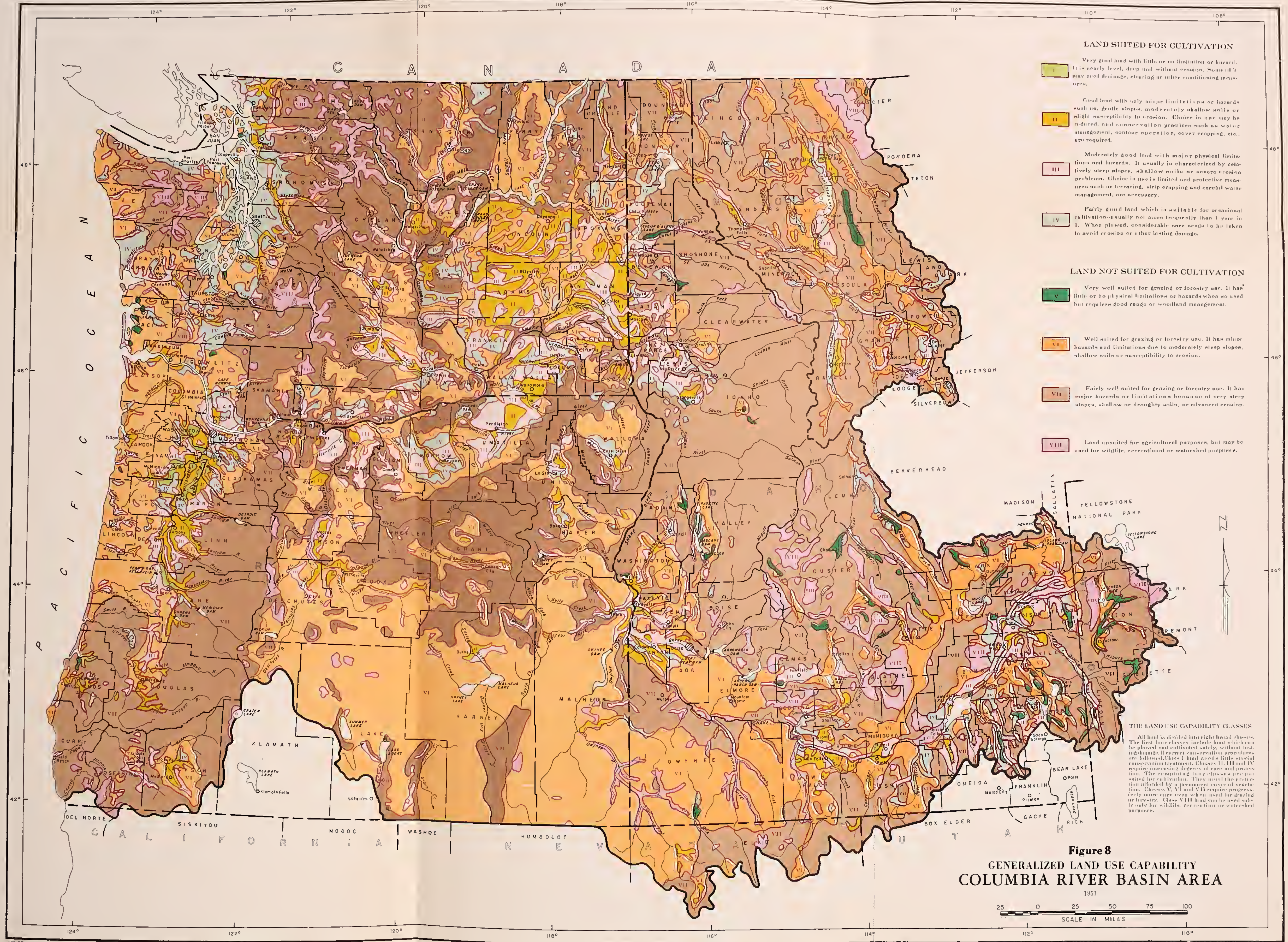


Figure 8
GENERALIZED LAND USE CAPABILITY
COLUMBIA RIVER BASIN AREA
1951

Table 3.--Acreages of Land by Use and Capability Class
Columbia River Basin Area, 1950

Capability class	Land use: Cropland	Land use: Non-forested range	Land use: Forest	Total
	1000 Acres	1000 Acres	1000 Acres	1000 Acres
I	591	7	23	621
II	5,961	341	223	6,525
III	6,907	893	899	8,699
IV	4,439	2,197	3,003	9,639
V	59	852	591	1,502
VI	565	34,918	30,289	65,772
VII	4	23,999	47,215	71,218
VIII	0	1,051	2,312	3,363
Total	18,526	64,258	84,555	167,339 1/

1/ The acreage not accounted for in this classification includes areas occupied by cities and towns, roads, railroads, airports and other miscellaneous uses.

perennial vegetation which can be cultivated occasionally. It is subject to very severe limitations because of moderately steep slopes, serious erosion potential, unfavorable soil characteristics, or adverse climate. The major areas of this class are located on the old coastal marine terraces and glacial plains west of the Cascade mountains. It is also found on the margins of the summer fallow wheat belt of Oregon, Washington, and Idaho, where climate is the limiting factor.

Land Not Suited for Cultivation

Class V land is very well suited for grazing or forestry uses with few or no permanent limitations. It usually has deep productive soil and is nearly level or slightly sloping, but has either a high water table or large stones which make cultivation impracticable. It includes tide lands and mountain meadows with deep soils and boulder strewn valleys.

Class VI land is well suited for grazing or forestry uses under careful management. It may be too steep, or subject to erosion, or too wet, or too dry, or with shallow soils unsuitable for cultivation. Land in this class is located mainly on the foothills, the less rugged mountain slopes, and the plains and plateaus.

Class VII land consists of fair to poor sites for grazing or forestry uses. It may be very steep, eroded, rough, shallow, dry, or with other characteristics which severely limit the growth or use of the vegetation. The higher and steeper mountain slopes, rough foothills and very stony plains and plateaus with shallow soils, are included in this class.

Class VIII land is suitable only for wildlife, recreation, or watershed. It includes rock outcrops or other barren areas that cannot support a vegetative cover; wet areas that are not practical to drain; land so steep that it cannot withstand the disturbances to vegetation that occur when used for cultivated crops, grazing or forestry.

Land Cover,Use and Ownership

The vegetative cover on the land has resulted from a combination

of natural factors and man's activities. Among the natural factors which influence land cover are: geology, topography, precipitation, wildlife population, and fire occurence. Man's activities include: cultivation, irrigation, logging, livestock grazing, fires, transportation and urban developments.

The use of land has evolved as a result of natural limitations and man's efforts and is a generalized indicator of cover type. However, there are many variations in kind and density of vegetation within each type of use. Land use types as shown in Figure 9 are cropland, rangeland, forest land and other. Figure 10 and Table 4 show the generalized use of the land within the Columbia River Basin Area by ownership.

Table 4.--Acres of Land by Ownership and Land Use Type
Columbia River Basin Area, 1950

Type of ownership	Land use type: Forest	non forested range	Cropland: Irrig	Cropland: Non-irrig	All other	Total
	1000 Acres	1000 Acres	1000 Acres	1000 Acres	1000 Acres	1000 Acres
Federal						
USDA	44,687	7,916	3	12	2,313	54,931
USDI	8,948	27,675	198	533	2,185	39,539
Other Federal	70	853	0	1	54	978
Total Federal	53,705	36,444	201	546	4,552	95,448
Local Government						
State	4,011	3,454	8	196	204	7,873
County & Municipal	197	12	0	0	9	218
Total	4,208	3,466	8	196	213	8,091
Private						
Total 1/	26,642	24,348	3,896	13,679	2,418	70,983
Net Land Area	84,555	64,258	4,105	14,421	7,183	174,522
Water Surface Area						1,800
Gross Area						176,322

1/ Includes County and Municipal lands not under specific management.

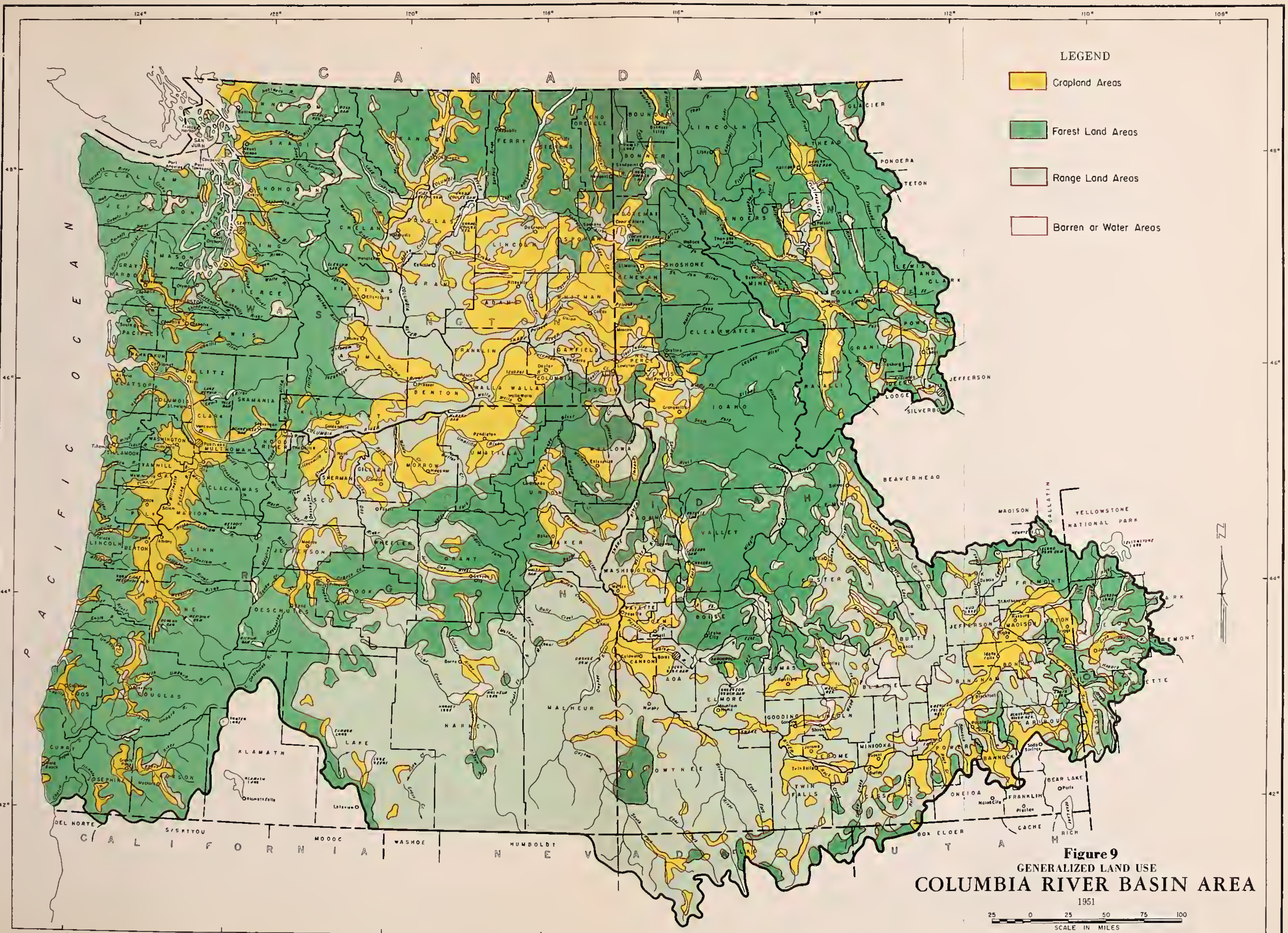
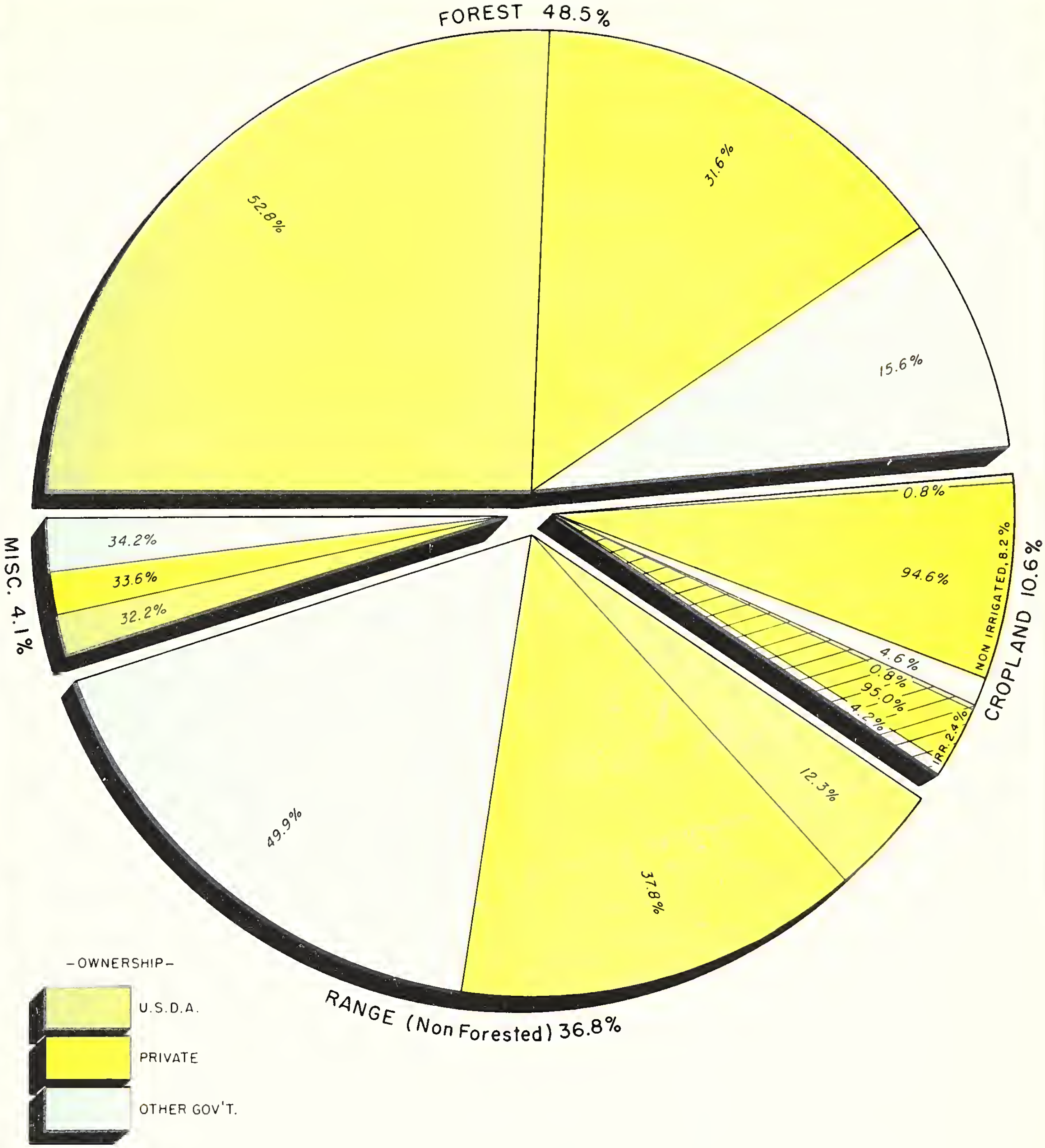


Figure 9
GENERALIZED LAND USE
COLUMBIA RIVER BASIN AREA
1951



LAND TYPE AND OWNERSHIP

COLUMBIA RIVER BASIN AREA

July, 1952

Cropland

There is an extreme variation in the vegetative cover on the 18.5 million acres of cropland in the Columbia River Basin Area. This variation is due largely to the diversity of crops grown and the management practices used in the growing of these crops. Crops grown include fruits, nuts, and berries; row crops, such as potatoes, sugar beets, and truck; grain and other close seeded crops; and sod crops, such as hay pasture in a rotation. Some lands lie fallow each year. Table 5 shows the distribution of cropland use by states, and Table 6 shows the irrigated and non-irrigated areas by states.

The amount of effective cover on the land also varies considerably by geographic areas within the basin. West of the Coastal mountains, over two-thirds of the cropland is used for grass-type crops. On the semiarid Columbia Plateau, in the central part of the basin, over 40 percent of the cropland is in fallow, which leaves it practically bare of vegetative cover. Orchards occupy about 7 percent of the cropland in the central Washington valleys and in the Willamette Valley in Oregon. Nearly half of the row crops in the basin are grown on the Snake River Plain, where potatoes and sugar beets are the major crops. Small grains are grown on from one-fourth to one-half of the cropland in all areas except on the coastal section and the closed basin.

Table 5.--Acres of Cropland by Generalized Use Classes
Columbia River Basin Area, 1950

State	Generalized use classes					
	Orchards 1/	Row Crops	Close seeded crops	Sod crops	Fallow	Other misc.
	Acres	Acres	Acres	Acres	Acres	Acres
California	0	0	0	0	0	0
Idaho	16,401	407,110	2,126,102	1,322,959	667,683	87,145
Montana	2,000	12,975	213,776	402,461	66,295	4,993
Nevada	0	0	2,184	74,960	0	0
Oregon	161,828	143,727	1,995,057	1,593,129	996,960	309,399
Utah	0	0	2,260	9,240	500	0
Washington	142,660	168,960	3,428,010	1,238,380	2,468,750	349,540
Wyoming	0	360	27,440	77,690	5,000	0
Total	322,889	733,132	7,794,829	4,718,819	4,205,188	751,077

1/ Orchards as used in this table includes cropland planted to bearing and nonbearing tree fruits, nuts, hops, vineyards and cane or bush fruits, excluding noncommercial family plantings.

Table 6.--Irrigated and Nonirrigated Cropland
Columbia River Basin Area, 1950

State	Irrigated cropland	Nonirrigated cropland	Total cropland
	Acres	Acres	Acres
California	--	--	--
Idaho	1,919,582	2,707,818	4,627,400
Montana	353,966	348,534	702,500
Nevada	69,964	7,180	77,144
Oregon	1,072,177	4,127,923	5,200,100
Utah	8,000	4,000	12,000
Washington	589,048	7,207,252	7,796,300
Wyoming	92,016	18,474	110,490
Total	4,104,753	14,421,181	18,525,934

Rangeland

The rangelands of the Columbia River Basin Area comprise about 64.3 million acres of nonforested land (Table 7). About 70 percent of the forested land (59.2 million acres) also supports livestock and big game grazing.

Table 7.--Acres of Range by Types and by Ownership
Columbia River Basin Area, 1950

Type of ownership	Nonforested range	Forested range	Total range
	Million acres	Million acres	Million acres
Federal:			
Dept. of Agriculture	7.9	31.3	39.2
Dept. of Interior	27.7	6.3	34.0
Other public	4.4	3.0	7.4
Private	24.3	18.6	42.9
Total	64.3	59.2	123.5

There are three general types of areas and the characteristics of each are influenced by climate, soils, and elevation. The summer range areas at the higher elevations are characterized by large expanses of open grassland, perennial weeds, and browse on side slopes and ridgetops, with groups of trees interspersed in the ravines and on the northern exposures. Some of these areas are mountain meadow and meadow type range along stream bottoms. The cover is predominantly succulent weeds, both annual and perennial, grasses and grasslike plants, and shrubby browse plants. Some of this range is

heavily grazed by sheep and cattle during the summer months, and during a more extended season by big game animals such as deer and elk. In some areas, as a result of this heavy grazing use, the native perennial grasses, sedges, and more palatable weeds have been replaced by less palatable plants.

The open rangelands just below the lower fringes of the timbered areas and at intermediate elevations have more extensive grasslands than the summer range. These areas furnish spring and early summer feed for livestock. Originally, they supported perennial grasses and sedges, but because of overuse, the cover over wide areas consists of inferior species. Cheatgrass, an annual of short seasonal life, is one of the chief invaders. Sagebrush and noxious weeds, of which St. John's-wort or goatweed is a noted example, also have materially increased.

Vegetative cover on the more gently sloping rangelands at lower elevations and the intermediate plains country is characterized by grasses, weeds, and sagebrush. These lands include plateaus, river bottoms, and flats and benches. Here again, over extended areas, grazing pressure by both domestic stock and big game animals has resulted in a replacement of the perennial grasses and shrubs by cheatgrass and annual weeds. Noxious weeds, including goatweed, halogeton, and Medusa-head wildrye, are prevalent in parts of these areas.

The condition of rangelands varies considerably over the Basin area. About half of the nonforested rangeland is in poor condition. Generally these lands have little protection against soil erosion and have a low water intake rate (Table 8).

Forest Land

About 48 percent, or 84½ million acres, of the Basin area is classes as forest land; that is, with 10 percent or more tree cover, or land from which trees have been removed but which is used primarily for timber production, or land with brush cover which influences water yields. Nearly 54 million acres are owned and administered by the Federal Government, 4 million acres by local government, and 26½ million acres are in private ownership. These private lands include a major part of the best timber-growing sites.

Three commercially important timber types cover the bulk of the forest area. The Douglas fir type occupying 33 million acres over the whole basin, is the predominant type west of the Cascades. The ponderosa pine type occupies nearly 17 million acres and is located largely in the foothills and lower mountains east of the Cascades. Western white pine occupies 4 million acres and is concentrated largely in the mountains of northern Idaho. (See Figure 11)

Becoming important commercially as access and utilization improve and as the more desired species become less available are the lodgepole pine type and the spruce-fir-hemlock type. The lodgepole pine type occurs primarily in the Rocky Mountains, but small areas are scattered throughout the Cascades. It occupies over 9 million acres. The spruce-fir-hemlock type covers the higher elevations in the Cascades and Blue Mountains and is scattered over the western Rockies. It occupies 7½ million acres.

Noncommercial forest, generally made up of thin stands of poor quality timber at the higher and less accessible elevations, covers

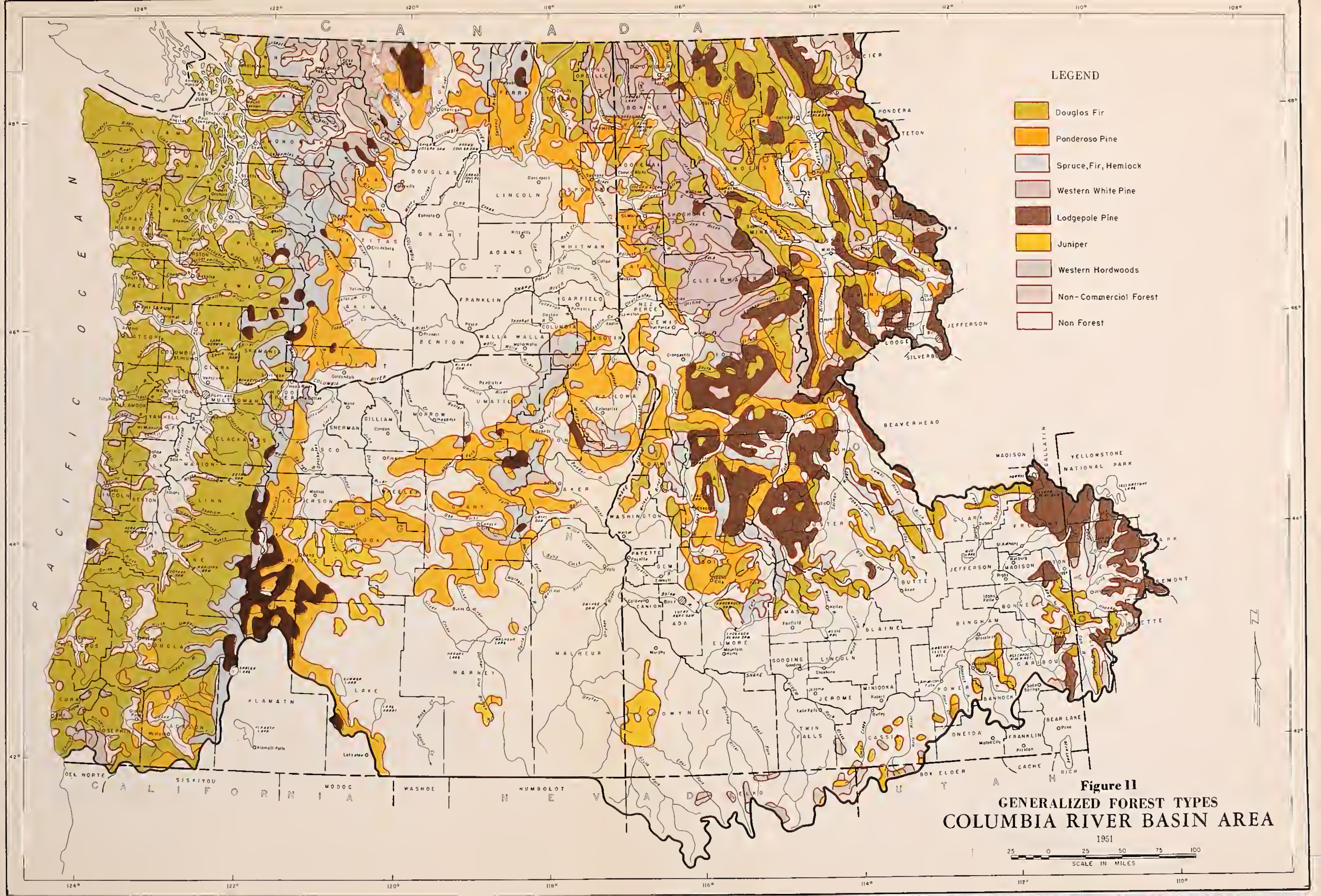


Figure 11
GENERALIZED FOREST TYPES
COLUMBIA RIVER BASIN AREA
1951

Table 8.--Condition Classes of Range Cover Usable by Livestock in Public and Private Ownership, Columbia River Basin Area

Range cover types	Good	Fair	Poor	Total
	(Millions of Acres)			
Mountain brush	0.7	1.4	1.5	3.6
Sagebrush-rabbitbrush-desert shrub	4.7	11.7	18.5	34.9
Perennial grasses and forbs	4.4	6.2	6.4	17.0
Meadow	0.4	0.6	0.6	1.6
Annuals	1.1	1.8	4.3	7.2
Total nonforested range	11.3	21.7	31.3	64.3
Forested range	19.5	22.4	17.3	59.2
Total forested and nonforested range	30.8	44.1	48.6	123.5

nearly 12 million acres. It is important primarily for watershed protection. At lower elevations, and the fringes of the open range in the southern portion of the basin, the juniper type occupies over one-half million acres. Some of the juniper is used for fuel and fenceposts. The western hardwoods type occurs in small patches scattered over the basin, but for the most part in coastal areas. It includes alder, cottonwood, maple, oak, madrone, and chinquapin and occupies a little over a million acres. Some of the hardwoods are used for furniture making, some for fuelwood, and some for paper pulp.

The Douglas-fir type west of the Cascades is the basis for a large part of the lumber industry in the basin. With its associated species, western hemlock, Sitka spruce, western redcedar, and the true firs, it supplies great volumes of wood for all kinds of lumber, veneer, paper pulp, fuel, and a variety of minor uses. East of the Cascades, Douglasfir and the associated larch, Engelmann spruce, and true firs are considered less desirable but still are used in quantity. In the interior of the basin, ponderosa pine and western white pine are the prime commercial timber species, and are the mainstay of the lumber industry.

In addition to providing the renewable timber resource on which a large segment of the basin economy is based, the forest land also is the prime source of water for the streams of the area. Forest cover is important in relation to regulation of snow accumulation, snowmelt, streamflow peaks, water quality, and water supply for municipalities, industry and for millions of irrigated acres of crop-

land. Much of the forest land, particularly in the ponderosa pine type, produces forage for livestock and big game. The forest land is also used extensively for recreation and is a significant tourist attraction.

Farm Land

The present stage of farm land development involves a span of slightly more than a century. There was some farming on a small scale in the western part of the area in the late 1820's and 1830's, but the great migration to western Oregon and western Washington did not get under way until the 1840's. Settlement in the eastern part of Washington did not begin until the late 1850's, with settlement beginning in eastern Oregon somewhat later. The beef cattle industry was the first enterprise developed in the eastern area, but it did not take long for the settlers to discover that parts of the area were highly productive for wheat. The first permanent settlement in the Idaho part of the Basin area was at Lewiston in 1861. Throughout the valleys of Idaho irrigation was practiced from the very beginning of settlement.

The range livestock industry in southern Idaho, western Wyoming, and Montana and in eastern Washington and Oregon was developing rapidly by 1870. Livestock numbers increased greatly during the next 30 years. Since 1918, sheep numbers have declined markedly. For example, in southern Idaho the number of sheep declined from 2,650,000 in 1918 to 1,109,000 by 1950. In contrast to sheep, cattle use of the grazing lands has increased during the last twenty years.

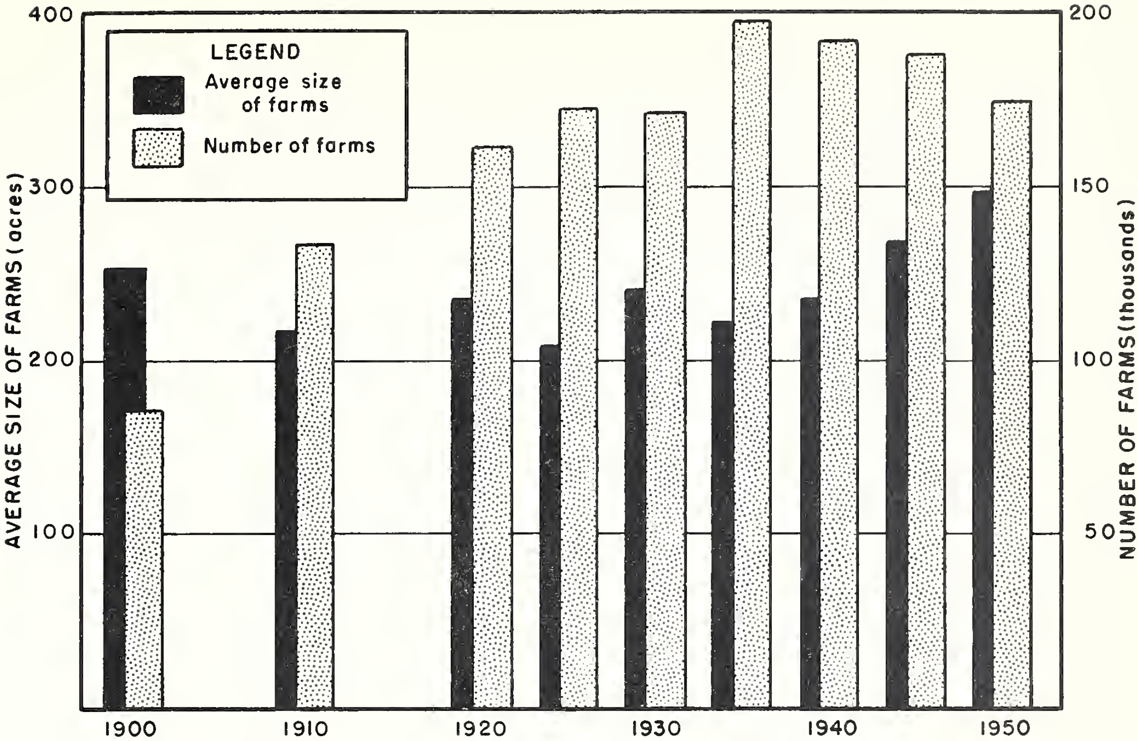
Although 9.2 percent of the total land area of the United States is in the Columbia River Basin Area, only 4.5 percent of the land in farms is in this area. Other relationships are shown in Table 9.

In 1950, 173 thousand farms were reported in the area. This is a decline from the peak of 199 thousand farms reported in 1935. Average size of these farms in 1950 was 301 acres per farm as contrasted with an average of 220 acres per farm in 1935. Farms with irrigated lands averaged 351 acres in 1950. Although the average size of all farms was 301 acres, almost half of the farms reported in the census in 1950 were under 50 acres in size (Fig. 12).

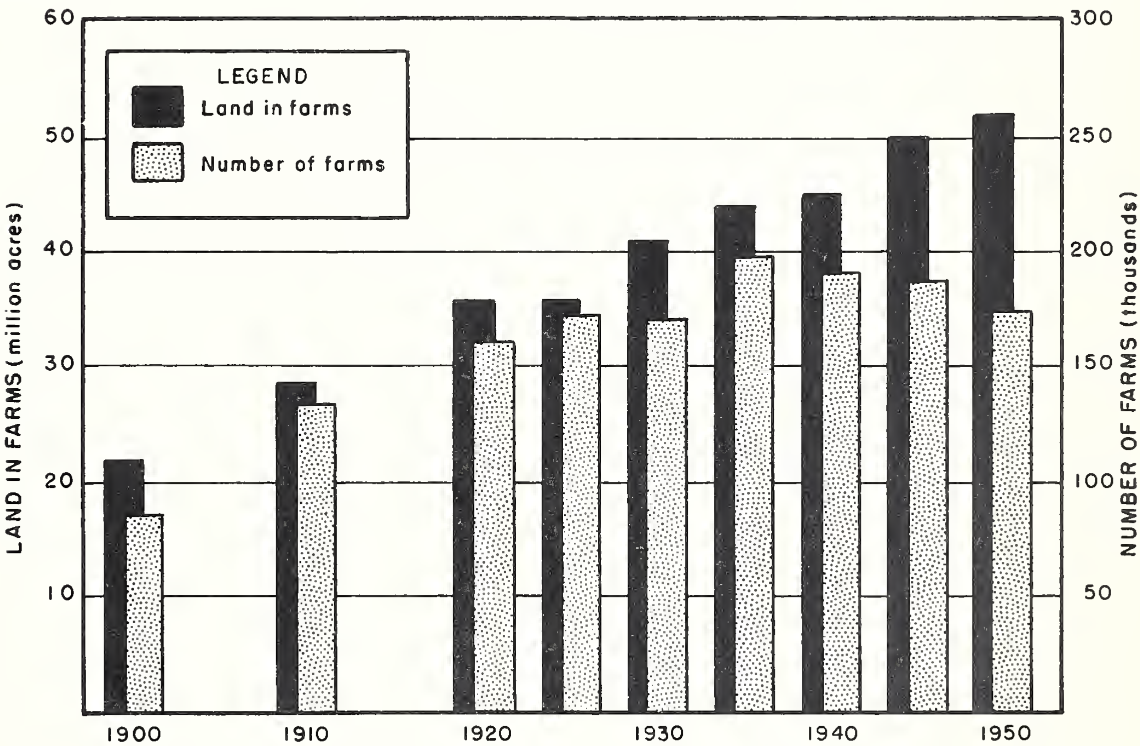
There is a wide variation in farm land use. In many areas only a relatively small proportion of the land in farms is available for cropping. Only in the Big Bend-Palouse wheat area and the Willamette Valley is as much as 50 percent of the farm land available for cropping. Pasture land of all types is of major importance.

In the coastal area of Oregon more than 50 percent of the land in farms is in forestry use. Farm forest land use is of less importance in the coastal areas of Washington and in the Upper Columbia area.

More than 100 thousand farms are classified as to type. Dairy farms and general field crop farms (primarily wheat) are of equal importance as far as numbers are concerned. Each of these types includes approximately one-fourth of all classified farms. Range livestock farms account for 17 percent, general farms 16 percent, fruit and nut farms 10 percent, poultry farms 8 percent, and vegetable farms 3 percent. The unclassified farms are predominately



Number of farms and average size, Columbia River Basin Area. 1900-1950



Number of farms and all land in farms, Columbia River Basin. Area 1900-1950

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U S DEPARTMENT OF AGRICULTURE

Figure 12

Table 9.--Comparison of Select Agricultural Statistics United States & Columbia River Basin Area, 1949-50

Item of comparison	Unit	United States	Basin Area	Percent area is of U.S.
Net land area	1000 acres	1,903,825	174,522	9.2
Land in farms	1000 acres	1,159,789	52,202	4.5
Land area in farms	percent	60.9	29.9	
Cropland, all	1000 acres	479,371	18,439	3.8
Cropland harvested	1000 acres	345,528	11,095	3.2
Irrigated land	1000 acres	25,832	4,089	15.8
Number of farms	Number	5,379,250	173,331	3.2
Number of commercial farms	Number	3,703,412	107,928	2.9
Value of farm products sold	$1000	22,279,563	943,244	4.2
Total population	Number	150,697,000	4,614,026	3.1
Rural population	Number	54,230,000	1,982,149	3.7
Rural farm population	Number	23,048,000	682,569	3.0

part-time farms or rural residences.

A wide diversification in soils, climate, topography, and crops can be found in many parts of the basin. The Willamette Valley is an outstanding example of this diversification. Although there is this diversification, there are concentrations of certain types of farming. For example, about one-third of the dairy farms are located in western Washington. Two-fifths of the fruit and nut farms are in the Yakima-Okanogan area.

More than 100 different crops and livestock products are produced commercially, and the importance of any one varies considerably from area to area. Some specialty crops such as mint and hops are

of major importance in certain areas. Again, even though of relatively minor importance to the Columbia River Basin Area, national production of certain crops such as filberts and hops is concentrated largely in this basin.

In this report relative importance is shown only in terms of amount of land from which the crop is harvested. Wheat is the most important farm crop. Wheat was harvested from 46 percent of the cropland harvested in 1949, and 44 percent of this acreage was in the Big Bend-Palouse area. Hay was harvested from about 25 percent. Wheat, hay, barley, oats, grass seeds, dry field peas, truck crops, potatoes, dry edible beans and sugar beets accounted for 93 percent of the cropland harvested in 1949.

The production of livestock through utilization of the forage on range lands is an important part of the agricultural enterprise of the Basin area. In 1949 crops were harvested from 11 million acres of land, but it is estimated that 64.3 million acres of open range lands were in grazing use. An additional large acreage of forested land is also grazed by livestock.

There were 3,021,000 head of cattle and calves in the Columbia River Basin Area on April 1, 1950. Of these, 22 percent were milk cows. There were also 2,764,000 sheep and lambs reported. Less than a half million hogs were reported on farms in 1950.

In addition, 8,143,000 chickens 4 months and older were on farms on April 1, 1950. In 1949, 2.9 million turkeys were raised. More than three-fifths of these turkeys were raised in Oregon with that production concentrated largely in the Willamette Valley.

The value of all farm products sold in 1949 amounted to more than 943 million dollars with 55 percent of the value coming from crops, 44 percent from livestock and livestock products, and only 1 percent from farm woodlot.

Distribution of this income is important. Of the 173 thousand farms classified, 108 thousand or 62 percent were considered as commercial farms. The relative importance of commercial farms is presented in Table 10.

Table 10.--Comparison of Commercial Farms With Other Farms Columbia River Basin Area, 1949

Item	Total in Basin	Percent commercial farms	Percent other farms
Number of farms	173,000	62	38
Number of farms under 10 acres in size	28,500	25	75
Land in farms	52,200,000 acres	92	8
Cropland harvested	11,100,000 acres	96	4
Value of all farm products sold	$943,200,000	98	2
Value of all crops sold	$520,600,000		
Value of livestock sold alive	$215,000,000	97	3
Value of dairy products sold	$118,400,000	96	4
Value of poultry or poultry products sold	$ 66,000,000	95	5

Many farm products are produced in quantities greatly in excess of the area's needs. Markets for these products must be found elsewhere either for the goods in fresh state or in some processed form. A large quantity of farm products is now processed in the Basin area.

In the three Pacific Northwest states, there were more than 1,500 establishments in 1947 concerned with the processing of food and kindred products. These establishments employed almost 50,000 persons. The processing done by these plants added 300 million dollars to the value of the product.

Forest Resources

Timber-cutting operations began about a century ago with the first settlement of the Basin area, and the lumbering industry has since been prominent in the economy. Though the past timber harvest has covered more than half of the 66 million acres of commercial forest land, there remains a sawtimber volume of 730 billion board feet of timber within the basin. Old-growth timber is now located largely in less accessible areas, and more and more of the readily accessible second-growth is being cut. Average annual timber production is now about 15 billion board feet. The value of primary forest products was estimated at $829 million in 1951; this includes all sawlogs, veneer logs, pulp logs, piling, and poles and other minor products.

All but a fraction of one percent of the timber harvested is from softwood coniferous species. Douglas-fir contributes about 58 percent of the total volume, the spruce-fir-hemlock type about 19 percent, and ponderosa pine about 14 percent. Added to the timber harvest is the drain on the forest caused by losses from fire, insects, and disease. This drain is estimated at nearly two billion board feet each year. The 16.4 billion total drain is about three times the 5.5 billion net growth in terms of sawtimber, and a little

less than twice the net growth in terms of cubic foot volume of all timber.

Table 11.--Volume of Commercial Timber by Type of Ownership
Columbia River Basin Area, 1945

Type of ownership	Saw timber	All commercial timber
	Billion board feet 1/	Billion cubic feet
National forest	330.5	75.7
Indian	22.3	5.1
Other federal	58.2	13.3
State	40.9	9.3
County & municipal	9.6	2.2
Private	269.0	62.1
Total	730.5	167.7

1/ International Rule

The most significant aspect of the drain-growth ratio is the marked difference in quality between the relatively high-grade volume being harvested and the presently low-grade volume in the growing stock. This disparity in quality has already seriously affected the forest economy of some areas and will undoubtedly affect the whole pattern of forest management and utilization in the area in the future.

Though the present timber harvest may not exceed allowable cut in many areas because of increasing utilization and increasing growth rates as stagnated overmature stands are removed, there is basin-wide a proportional overcutting of high quality trees and

favored species. The supply of high quality, large size, old-growth Douglas-fir now commanding a premium market in the plywood industry will be virtually exhausted within 30 years at the present rate of cutting. In the interior and eastern parts of the basin, half of the total lumber production is ponderosa pine and western white pine; but those species make up only a third of the inventory.

About three-fourths of the timber cut is taken from old-growth stands for the basin as a whole. Ninety percent of the cut from both old and young stands is classed as sawtimber, and the remaining ten percent as fuel, poles and piling, pulpwood, and fenceposts. The sawtimber includes logs used for plywood manufacture and paper pulp as well as for lumber. Western hemlock and true fir logs go primarily into paper pulp, while Douglas-fir goes into lumber and veneer, and ponderosa pine into lumber. Eighty percent of the log production comes from privately owned lands, and most of the remainder from Federal lands. Farm woodlots over the basin now contribute over 10 million dollars' worth of forest products annually, a small though significant part of the total timber values produced.

Sustained yield capacity of the commercial forest land in the Columbia Basin area has been estimated at 14 billion board feet of sawtimber (International Rule) annually. A little more than 40 percent would come from private forest lands. Most of the production would be logs, about ten percent of which would go to paper pulp manufacture. Though small at present, the production of pulpwood bolts is steadily increasing.

Reaching the sustained yield capacity requires getting full

growth, by planting and seeding, on forest lands now nonstocked or poorly stocked and on the ultimate conversion of all old-growth stands to productive, managed second-growth. This sustained yield capacity represents the ultimate allowable annual cut and may be increased somewhat as better access and utilization make possible greater intensity of management.

Over 60,000 people are employed in logging, and an additional 140,000 in primary timber manufacture in the basin area. Most of this labor force is concentrated in Oregon, Washington, and northern Idaho. Value added by manufacture is more than one billion dollars. Principal products include rough and finished lumber of all kinds, pulp for paper and rayon, plywood, fibreboard, box shook, and shingles. While future demand for labor in the sawmills may decrease as the high quality old-growth timber is depleted, employment in pulp and paper-board and wood-chemical plants will increase.

Other Resources

Wildlife

The fish and wildlife of the Columbia River Basin Area are important both from the recreational standpoint and that of the value of the food and fur they produce. Originally, the basin teemed with big game, fur bearers, waterfowl, and fish. However, settlement and development of the area have had a profound influence on these animal populations.

The many perennial streams draining the forest lands once provided ideal habitats for salmon and trout. Sedimentation and pollution have destroyed or seriously damaged the habitat in several

streams, but the basin area still remains as one of the better fishing areas of the nation. Water covers 1.8 million acres and provides sport for more than a million fishermen each year. State fish and game departments raise and plant millions of trout and other fish to help meet the demand. The commercial salmon fishery annually takes about 30 million pounds of fish spawned in the Columbia River system.

Streams, lakes, and forested mountains offer a favorable habitat for numerous fur bearers. Beaver, fisher, marten, mink, muskrat, otter, skunk, and weasel are found throughout the basin. The fur hunters and traders were the first visitors to the area. Trapping furbearers still provides an income of about one million dollars annually over the basin, although the most desirable animals have become fairly scarce.

Big game populations include over a million deer, about 180,000 elk, 25,000 antelope, 3,000 bighorn sheep, 14,000 mountain goats, 5,000 moose, and more than 50,000 bear. The deer are of three species: mule, blacktail, and whitetail. In recent years, nearly 600,000 hunters take to the field every fall in search of big game.

Uplands birds available to sportsmen include the introduced Chinese pheasant and Hungarian partridge, and the native grouse, quail, prairie chickens, doves, and pigeons. The introduced birds are increasing in numbers, while the native species are declining. Songbirds are everywhere abundant. Small game such as rabbits, squirrels, and raccoon occur throughout the basin, and provide sport to young hunters.

Millions of migratory waterfowl and shorebirds depend on the

larger lakes and streams for food, shelter, and nesting sites. Established refuges cover 270,000 acres. Natural habitats are now quite restricted. More than 360,000 hunters each year are in the field hunting the migratory and upland birds and small game.

Predator populations are low over most of the area. Mountain lion and lynx are scattered through the forested area, while coyotes and bobcats are common to the entire basin. Cooperative control programs by the states and the Fish and Wildlife Service keep their numbers down. Mice, rats, gophers, ground squirrels, and rabbits adversely affect crop production and range forage, and are subject to control in many areas where natural predators do not keep their numbers low. Porcupines are increasing within the forests, and do considerable damage to the growing timber in some areas.

Recreation

Outdoor recreation is a significant and rapidly growing use of the wild lands. Nearly eleven million recreational visits are made each year to national forest areas, and more than four million to the national parks and monuments. State parks also draw more than nine million people each year. This use is constantly expanding, and increases the problems and costs of protection and management. More and more facilities are needed to meet recreation demands. Many communities are largely dependent upon income from tourists, campers, hunters, fishermen, and winter sports enthusiasts. On the national forests alone, there are 1,500 camp and picnic areas, about 80 winter sports areas, about 150 organization camps, nearly 500 hotels, and 5,400 recreation residences.

The total income from recreational use of the basin wild lands, largely concentrated along streams and lakeshores, is estimated to amount to several hundred million dollars annually. For example, expenditures by out-of-state tourists in Washington are estimated at about $120 million each year, of which some $5 million is paid in the form of sales taxes, gasoline taxes, and city admission taxes. Aside from the monetary aspects, this recreation use is significant in providing opportunity for rest, aesthetic enjoyment, and inspiration to the local population and to many outsiders. Recreation use is desirable as an aid to social and individual health and enjoyment, and will continue to grow as the basin population grows.

Minerals and Mining

The full extent of the mineral resources is not known, but certain localities have been thoroughly mapped. On the basis of the geologic structure, it is certain that only a few of the great subsurface deposits have been discovered.

Production of copper, zinc, silver, lead, and gold in northern Idaho and western Montana averages about 110 million dollars annually. In central Washington, nearly a million tons of good quality bituminous coal are produced annually. The tremendous phosphate reserves of southern Idaho are just beginning to be developed. Pumice is mined for building block material in central Oregon and central Washington. Other minerals are mined in various locations scattered over the basin.

Three-fourths of the mining employment is in northern Idaho and western Montana. Over-all employment in this industry is about 60,000. Refining of minerals is done at plants in western Washington, western

Oregon, northern Idaho, and western Montana. Alumina is shipped into the basin for processing at several aluminum plants; and various minerals are shipped out of the basin for processing elsewhere. Numerous by-products such as sulphuric acid, explosives, and fertilizers are derived from the refining processes.

Transportation and Commerce

The area as a whole is dependent upon a well developed and maintained transportation system for the efficient marketing of agricultural products. Air, land, and water transportation have a high level of development. Five major transcontinental railroads serve the basin area. In general, the road system is adequate for the farming areas although constant modernization and improvements are required. In farm areas now undergoing development, local road systems frequently are not adequate. Forest access roads are also inadequate for proper management and utilization of forest resources. The river systems are important in the movement of logs and various agricultural products. Ocean going vessels move inland to Portland on the Willamette.

For the entire area almost one-half of the farm operators live less than five miles from the normal trading center which is usually their marketing center too, with almost one-fourth 10 miles or more from the normal trading center. Distances from trading center are the greatest in the grain and range livestock areas.

Condition and types of roads farmers must use in getting their products to market can have a significant effect on the condition of the products when they reach the market. Rough roads can cause considerable bruising, unnecessary delays, or other damages. Data

on condition of roads are not available, but we do know on what types of roads farmers live. More than 40 percent of the farmers live on hard surface roads, 43 percent on gravel or other improved roads, and 16 percent on dirt or unimproved roads. However, in traveling to trading centers one-fifth of the farmers must travel between one and five miles on dirt or unimproved roads, while six percent must travel five or more miles on this type of road.

The maintenance of adequate trade channels is essential to the entire economy of the Columbia River Basin Area. On April 1, 1950, more than 489 thousand persons were employed in transportation, communications, public utilities, wholesale trade, and retail trade. It is not possible to determine what proportion of these served only the agricultural and forestry industries although most of these served agriculture and forestry at least indirectly. Included in this number were 149 thousand employed in transportation, communications, and utilities. More than 64 thousand were in the wholesale trade, and 275 thousand were in the retail trade. Many persons in these trades handle agricultural or forestry products. The services they supply range from transportation or storage of the raw products to sale of the consumer product at the retail level.

AGRICULTURAL PROGRAM NEEDS

The Columbia River Basin Area, as has already been pointed out, includes great variations in climate, physiography, geology, soils, settlement and crop adaptations. The problems of conservation, development and use of the agricultural resources are complex, and the program needed to solve them varies widely from area to area.

The area west of the Cascade Mountains is semi-humid, except for a dry summer period. It is characterized by cropland problems involving floods and sedimentation, soil nutrient deficiencies, restricted drainage, weed and insect infestation, and soil acidity. Problems are accentuated by pressure of a rapidly increasing population and growing markets.

The forests are predominantly of the Douglas-fir type. Important forest problems include access to over-mature stands, protection from fire and insects, and reforestation. Dry summers create special problems for forest as well as cropland.

The area east of the Cascade Mountains has a drier climate than that to the west and is characterized by wider variations in climate, soils and agriculture. Irrigation is practiced in all provinces, but the four million acres under irrigation include small isolated ranches deep in mountain valleys, small groups and communities along minor water courses, and vast areas of a half million acres or more such as the Columbia Basin irrigation project and Snake River Valley. Irrigation development will further expand from individual small tracts to large projects up to 100 thousand acres. Irrigated crops include those involving both intense culture, as for truck crops and hops, and very

extensive culture as for domestic hay. Areas irrigated are for the most part similar in climate. Nearly all have complex drainage, irrigation and plant nutrient problems.

Cereal grain culture extends from central Washington and Oregon to the foothill areas of southeast Idaho. It is practiced in some areas of 10 inches or less precipitation and in other areas with 30 or more inches. Cropping patterns vary from summer fallow to annual cropping.

Extensive livestock and big game ranges are found among the high mountain slopes, mountain valleys, foothills, plateaus and desert plains. Season of use varies with elevation and with forage type. Variations in condition, cover and precipitation are extreme.

Wide variation in forest condition and type occurs. Major types include ponderosa pine, spruce-fir-hemlock, lodgepole pine, and western white pine. Fire and insect hazards are severe. Problems exist in access, utilization, marketing, protection and reforestation.

The large rivers and their principal tributaries yield tremendous flows of water; much of it is unharnessed and flows into the sea. Most of the small tributaries lack flood and irrigation storage facilities and are characterized by rapid runoff in late winter or spring and by deficient growing season water supplies. Problems affecting development of adequate facilities for flood and irrigation storage include lack of basic hydrologic data, financing, local organization, and economics. General information relating to ground water indicates great reserves are awaiting development, but adequate basic investigation of specific areas has only begun.

Cropland

The Columbia River Basin Area includes about 18.5 million acres of cropland of which approximately 4.1 million acres are irrigated. Another million acres will be irrigated by Federal projects now under construction and an additional four million acres have been estimated as potentially irrigable.

The highly diverse conditions greatly complicate its cropland problems. Rainfall varies from 7 inches in the arid parts of the Columbia Plateau to 100 inches along the coastal section. Growing seasons vary from less than 100 days per year in parts of the interior to more than 240 days in the valleys west of the Cascade Mountains. Crops range from such specialties as cranberries, mint and bulbs to large acreages of wheat, fruit, hops, potatoes, sugar beets, and various seed crops. Large acreages are devoted to livestock and dairy farming.

Problems in Non-Irrigated Areas

West of the Cascade Mountains the annual precipitation is sufficient to grow a variety of crops economically without irrigation. The predominantly non-irrigated diversified farms in the Willamette-Cowlitz-Puget lowlands, the flat lands adjacent to the lower Columbia, and the small valleys on the coastal streams comprise practically all of the agricultural lands in this area. Supplemental irrigation is now practiced, and there will be considerable increase where irrigation water can be made available economically.

In the lowlands west of the Cascades the principal enterprises are dairy, poultry and general farming. The valleys in the coastal

area are predominantly used for specialized dairy farming.

A major problem in this area is poor drainage. Production could be increased materially through improved drainage on about a million acres. There are about 100,000 acres, principally in western Oregon and western Washington, which require diking for protection against high tides or high river stages.

As the precipitation is heavy in the winter and deficient during the growing season, there is also a need for conservation measures that minimize surface runoff and erosion and conserve moisture for crop production during the summer. Other problems are created by localized floods, streambank erosion, and excessive leaching of plant nutrients.

On the Columbia Plateau an important limitation on agricultural production is the low annual precipitation. One of the primary problems is that of conserving all available moisture. In addition to measures that will accomplish this, there is need for practices to prevent wind erosion on the light soils, to restore organic matter and plant nutrients and to prevent water erosion on the slopes. This area is used almost exclusively for the production of cereal grains with the land maintained fallow in alternate years to accumulate nitrogen and conserve moisture. About a half million acres are now under irrigation and a total of about a million acres will be irrigated by the Columbia Basin Project.

In the Upper Snake River Plains low precipitation and a short growing season combine to limit production. The problems are similar to those on the Columbia Plateau with the primary need for practices

that conserve moisture. The non-irrigated farms in this area are used for wheat and general farming. The irrigated portions are used for the production of potatoes, dry beans, sugar beets, and livestock.

The Palouse and Blue Mountain foothills comprise a famous wheat producing area. There is sufficient rainfall to produce an annual crop, and peas are frequently alternated with wheat in a rotation. The steepness of the land, the susceptibility of the soil to erosion and the heavy winter season precipitation result in severe erosion. This, in turn, has given rise to serious sedimentation problems. There is an urgent need for land use adjustments and conservation measures that will prevent water erosion and at the same time conserve moisture.

In the narrow river valleys of northeastern Washington, northern Idaho and western Montana problems are created by the short growing season, localized flooding, inadequate farm and community drainage, water erosion on steep slopes, severe infestations of perennial noxious weeds, and deficient precipitation during the growing season. These areas are used largely for dairy and livestock enterprises. The irrigated portions of these lands are used for production of livestock feed and special crops.

Problems in Irrigated Areas

Approximately 4.1 million acres are irrigated by large Federal irrigation projects, by projects developed by private enterprise, by simple community diversions of water from streams, or by development of wells.

The irrigated valleys of the east slope of the Cascade Mountains

in Washington are used for fruit, livestock and mixed farming. In the Snake River Valley in eastern Oregon and western Idaho, dairy, hay and sugar beet production are the dominant farm enterprises. In the irrigated valleys of the Upper Snake, potatoes, dry beans, sugar beets and livestock predominate. General farming and livestock production are the primary enterprises in western Montana.

Moderate to critical deterioration has taken place on most of the irrigated lands of the basin area. Considerable areas of land have been water logged by the application of excessive quantities of water or by seepage from higher irrigated lands. In many areas alkali accumulations are limiting production.

On newly irrigated lands, such as those in the Columbia Basin Project, and in the Deschutes and Snake River Valleys, settlers need initial assistance in land preparation, in laying out farm irrigation systems, in planning cropping systems and in applying other conservation practices.

In many areas supplemental water supplies for irrigation are needed. This is particularly true in the tributary stream valleys where the present water supply is limited to the natural flow and is deficient for supplying the moisture requirement of crops for the full growing season.

Irrigation practices need to be improved to maintain fertility, prevent water logging, reduce erosion and conserve irrigation water.

Drainage Problems

The problem of inadequate drainage is a very important one in the Columbia River Basin Area. Productivity could be improved on more

than 2 million acres if better drainage were provided. The drainage problems are due to the combined effect of the normal precipitation and characteristics of soils and topography that impede natural drainage. The wet soils generally are heavy textured and often acid in reaction and they absorb and transmit water slowly. The existing natural drainage patterns frequently do not provide adequate channels to carry off the accumulations of heavy winter precipitation.

In the arid and semi-arid areas the drainage problems are largely the result of irrigation developments. The natural surface and subsurface drainage patterns of many of these areas could adequately provide for the orderly disposal of the normal low precipitation, but they will not permit the timely removal of excess irrigation water.

Irrigation of large acreages of bench lands frequently causes water to percolate into the subsoil of lower-lying lands. Excessive seepage from canals and ditches also contributes to the water-logging of bottom lands. The application of more irrigation water than is needed frequently is responsible for the raising of water tables to levels that have deleterious effects on crop production.

Drainage improvements are more urgently needed in the irrigated areas than in the humid areas. In the humid areas the poor drainage conditions restrict the use of the land and make it less productive, but the land is not permanently damaged. At any time these lands can be drained and their full potential realized. A large part of the land needing drainage improvement in the irrigated areas is subject to increasing soil deterioration from salt and alkali accumulations, due to the presence of salt and alkali in the soils and irrigation water.

Evaporation and transpiration leave ever increasing concentrations of salt or alkali in the soils. Improved drainage would permit the leaching out and removal of a large part of these concentrations.

Cropland Program Objectives and Scope

The objective of the cropland program is to use each acre within its capabilities and to treat each acre in accordance with its needs for protection and improvement. The application of the measures and practices described will insure the conservation of the soil resources and will also result in greater sustained production of food and fiber.

The concept of soil conservation has come to mean proper land use, protecting the land against soil deterioration, rebuilding depleted soil, conserving moisture for crop use, developing proper drainage and improved irrigation where needed, building up soil fertility, and increasing yields and farm income.

Erosion and declining soil fertility can be combated by such practices as crop rotations, fertilizers and amendments. Additional measures such as construction of terraces, diversion ditches, and contour strip cropping prevent runoff water from concentrating into damaging flows. The solution to the problem of soil deterioration varies considerably with the capability class of the land, the crops grown and climatic conditions. Farmers generally are making good progress in applying needed conservation measures to the land. Some measures are being widely applied, while others are only in limited use. The acreages of various measures needed, as shown in the following pages, represent the amounts needed beyond present applications.

Practices Principally for Soil Protection

Contour farming is farming slopes in such a manner that plowing, planting, cultivating and harvesting operations in the production of field crops and in orchards and vineyards follow lines that are level or conform to accepted standards for grades. This practice increases moisture penetration and helps control water erosion. It is frequently used in conjunction with terraces, field diversions, contour strip cropping, or contour planted tree or vine rows which provide permanent guide lines. All sloping lands where water erosion is a problem should be farmed on the contour. Cross-slope farming may be substituted in areas of broken topography where contour farming is impractical. A total of seven million additional acres of cropland should be farmed on the contour. This includes contour strip cropping and contour planting.

Contour strip cropping is the growing of field crops in a systematic arrangement of strips or bands laid out along or parallel to surveyed contour or grade lines and serving as vegetative barriers to run-off and erosion. Contour strip cropping is most applicable to wheat land in the higher and intermediate precipitation zones that has long and rather gentle slopes. This practice is recommended on about 3.5 million acres.

Contour planting of orchards, vineyards, cane fruits and other perennial rooted crops consists of laying out the crop rows so that they are level or on accepted standards of grades. This practice is required on irrigated land with slopes of such gradient or soil with such texture that irrigation water will cause serious erosion if

allowed to run on the full grade of the slope. Contour planting of irrigated orchards is particularly needed along the Columbia River Gorge, in the Yakima-Wenatchee-Okanogan Area, and in parts of western Idaho. Contour planting is also required on non-irrigated land in areas where rainfall and runoff are high. It is especially adaptable to sloping hill and terrace land west of the Cascades in Oregon and Washington. It is recommended that contour plantings be made on approximately 106 thousand acres.

Terraces are graded channels running across a slope at systematic intervals to intercept and control runoff and minimize erosion. The channels are constructed with supporting ridges on the lower sides and are laid out in a manner to permit them to be cultivated with the field. They are most applicable to wheat lands in the Blue Mountain foothill area of Washington and Oregon and in north central Oregon. Terraces are difficult to use where the topography is irregular and the slopes steep, and are not recommended in areas of heavy snowfall because of channel plugging by snowdrift and ice. About 6,900 additional miles of terraces are needed.

Field diversions are graded channels across the slope installed individually or in a series to intercept runoff, minimize erosion or prevent excess runoff onto lower-lying areas. The channels are constructed with supporting ridges on the lower sides. They are not cultivated with the field and usually are protected by vegetation. This practice is appropriate where runoff is a problem on sloping croplands. Areas in the basin where this practice is applicable include lands on the eastern edge of the Washington wheat belt nearest the mountains;

some lands in south central Washington; the narrow mountain valleys in Idaho; the eastern edge of the wheat belt in southern Idaho and near the mountains in northern Idaho; and the southern edge of the wheat belt near the Blue Mountains and in some of the mountain valleys in Oregon. Field diversions are recommended in conjunction with contour strip cropping on moderately sloping land and with hill top and pasture seedings on steep land. About 17,000 additional miles of field diversions are needed.

Field strip cropping is the growing of field crops in alternate bands in combinations of sod crops or close-grown crops with row crops or fallow crosswise to the prevailing winds. This practice is used primarily for wind erosion control. It provides greatest benefits under a rotation system of crop production with part of the land in grass and legumes. Field strip cropping is needed on about 1,344,800 acres.

Practices Principally for Soil Improvement

Crop residue utilization is the use of vegetative materials such as stubble, prunings and other residues on croplands in such a manner as to conserve moisture, increase organic matter and reduce wind and water erosion. This practice includes mixing the materials in the soil or leaving them wholly or partially on the surface. The utilization of straw and stubble or other crop residues as a surface mulch helps to control wind and water erosion during the periods when the land would otherwise be bare and unprotected. On most irrigated farms where row crops follow grain or corn, the stalks and stubble should be incorporated with the soil so that the surface will be free of trash

for best seed bed preparation. A surface mulch for strawberries, commercial vegetables and other row crops is sometimes provided by hauling on straw, hay, pea vines, sawdust or any other suitable vegetative material available. The important consideration is that all crop residues be returned to the soil and not be burned. The practice of crop residue utilization should be applied to all cropland. It is estimated that it is applicable on about 10,140,000 acres.

Subsoiling is tilling the soil below the depth to break a plow sole or clay pan. Soils that have developed a plow sole or have a clay pan which slows down the penetration of rainfall or irrigation water can be improved by subsoiling. In some irrigated soils of the high plateau areas in southern Idaho subsoiling to a depth of 10 to 14 inches once in each rotation cycle has proved to be a desirable practice. It also improves soils having a shallow hardpan as in the Yakima and Walla Walla valleys in Washington. Subsoiling on the contour is a good moisture conservation practice and helps prevent erosion on some of the wheat lands having silt soils. Approximately 1,622,000 additional acres of land should be subsoiled on the average of intervals of five years.

Other special tillage operations to conserve moisture and control erosion include basin listing, pit cultivating, contour listing, chiseling, rotary subsoiling and emergency furrowing. The first three measures are used for retention of water in areas where heavy rains occur during the late summer months and where there is not adequate vegetative cover to control erosion. Some lands are contour listed where they are to lie fallow during the winter months. Emergency

furrowing is frequently desirable in sandy soil areas where wind erosion is a problem. Furrows are plowed across the direction of the prevailing wind to serve as temporary barriers to sand drifting. Chiseling to break up hardpan layers or compact lime subsoils helps to increase moisture penetration in the semiarid zones on both non-irrigated and irrigated soils. Rotary subsoiling is desirable on many farms where fields are to lie fallow or under stubble during the winter months. This practice helps to prevent the formation of impervious frost layers and allow greatest winter infiltration. Special tillage operations of these types are required on about 3,009,000 additional acres.

Green manure and cover crops to improve and protect the soil are very important in the maintenance of croplands. They are grown primarily to supply organic matter and nitrogen, but do provide protection against erosion until they are turned under. They are composed of plants that provide a large mass of organic matter and usually include legumes which add nitrogen to the soil. Green manure incorporated into the soil after good growth is achieved improves the soil structure and maintains soil fertility. Cover crops are grown primarily to protect soil against erosion during the season of high rainfall and have an added benefit when they are turned under by supplying organic matter and nitrogen to the soil. There is need for these practices to be used on 3,243,000 acres with 737,000 acres applied annually.

Rotation seedings are the seeding of perennial grasses and legumes in a crop rotation. The purpose is to grow soil-improving crops in the rotation to offset the soil-depleting crops. Most row crops and

grain crops are usually classified as soil-depleting and grasses and legumes as soil-improving crops. Lands that are badly eroded or have steep slopes should be in soil-improving crops most of the time. More fertile, less steep lands with deeper soils can be maintained in permanent productivity with less frequent use of soil-improving crops in the rotation. It is estimated that this practice should be established on 6,992,000 acres requiring annual seedings of about 967,000 acres.

Liming is the application of lime to cropland to reduce soil acidity and to supply calcium for plant growth. Liming is necessary on those soils which have been depleted of calcium and magnesium through leaching and cropping to such an extent that maximum crop yields are no longer possible. A total of about 2,758,000 acres needs periodic applications of limestone, requiring that about 368,000 acres be treated each year.

Fertilizing is the adding of any material to the soil to supply one or more of the essential plant nutrients. The specific fertilizers needed vary considerably for different lands. The acid soils of the humid areas require applications of nitrogen, phosphorus and in many cases potassium, sulfur and boron to establish soil-improving crops and to increase production of other crops. Fertilizer needs in the dryland farming areas including approximately 11,050,000 acres, are closely associated with the decline in soil organic matter and nitrogen. Approximately 70,000 tons of nitrogen need to be applied annually. There is a definite need for phosphorus fertilizers on at least 50,000 acres of this area. Applications of sulphur are required for soil-improving green manure and legume hay crops. Boron deficiencies for

legumes are common in the higher rainfall areas. The soils of the arid and semiarid irrigated areas were originally low in organic matter and nitrogen. Phosphorus fertilization is generally required for high crop yields on soils that have been farmed under irrigation for more than 15 years. In addition, applications of boron and zinc are required to maintain high yields on at least 70,000 acres of tree fruits, vineyards and nuts. With more intensive cropping and additional years of farming the need for supplementary applications of nutrient elements will become more acute. Fertilizer applications are recommended on 6,483,000 acres annually for increased production of crops and on 410,000 acres annually rotated over 2,544,000 acres to promote growth of soil-improving crops.

Practices Applicable to Pastures

Pasture seeding is the seeding of cropland to grasses and legumes where the primary use of the land is for pasture. The land is farmed to other crops only frequently enough to control weeds. Occasionally it is reseeded to maintain desirable grasses and legumes. This practice is particularly applicable in western Oregon and Washington and in the irrigated areas east of the Cascades. Approximately 1,534,000 acres that are in pasture or for which the best use is pasture should be seeded at the proper intervals to maintain the more desirable plants. This would require that about 177,000 acres be seeded each year.

Pasture management includes the timing and orderly scheduling of practices to keep pastures producing high quality of forage over a long period. It involves such practices as rotation grazing, proper

stocking, mowing to control weeds, fertilizing, liming, seeding, scattering droppings, contour furrowing, or other methods to improve the vegetation for grazing purposes. Improved pasture management is needed on most of the pastures in the basin area. It is estimated that about 2,974,000 acres of pasture could be improved by better management.

Improving Irrigation Practices

Improper delivery and application of irrigation water causes serious damage to the land as well as the loss of valuable water for the irrigation of additional lands. Erosion, water-logging and alkali accumulations on irrigated land are destroying or severly damaging many acres each year.

The Columbia River Basin Area is popularly considered to be a region of abundant water resources, yet severe seasonal irrigation water shortages occur quite frequently in some localities. The benefits of irrigation could be extended to additional lands if more efficient use were made of existing water supplies.

There are considerable variations between projects and between farms in the same project, but as an overall average only one-fourth of the water diverted into main supply canals actually is used by the crops grown on the farms supplied by those canals. Nearly one-half of the diverted water is lost by seepage from the usually unlined canals and ditches in conveying it from the points of diversion to the boundaries of the farms. About one-half of the water delivered to the farms is lost by surface runoff or by deep percolation below

the crop root zones as the result of inadequate distribution systems or improper water application practices, or both.

Preparing land for irrigation is necessary for efficient water and land management. It is first necessary to determine the irrigation method that is most appropriate for the type of topography and characteristics of the soil to be irrigated. If surface irrigation is to be used, the land must be carefully leveled to permit good irrigation with a minimum amount of labor. If sprinkler irrigation is used requirements for land preparation are greatly reduced. For new lands being brought under irrigation, clearing of brush or other native vegetation and removal of rocks that would interfere with tillage operations must also be done.

Clearing, leveling, floating and other surface treatment is required on about 3,040,000 acres of land to permit efficient application of irrigation water. This includes about a million acres of new land being irrigated or to be irrigated by projects now under construction.

Improving water application is largely a matter of education. A large part of the water that is wasted and the damage that is done by over irrigation can be attributed to the irrigator's lack of understanding of the relation between the stream of water, the soil moisture reservoir in the crop root zone, and the damages resulting from over-irrigation. Irrigation practices should be improved on about four million acres of the land now being irrigated.

Improving and Developing Irrigation Systems

Improving farm irrigation systems is an important measure for increasing water application efficiency and conserving soil. On many

farms the irrigation runs are too long to get reasonably uniform application of water, irrigation grades are too steep to avoid excessive erosion, or the system used is not appropriate for the characteristics of soil and topography or the crops grown.

There has been rapid development since 1940 in understanding good farm irrigation system layout as prompted by the soil, the water supply, and the method of irrigation. Heavy earth moving equipment permits lands to be leveled more economically. These advancements have found rapid acceptance and farm irrigation systems are being revised. A more uniform application of irrigation water is being obtained by leveling lands and relocating ditches to allow more desirable lengths of run. Control structures are being installed to decrease ditch erosion and to facilitate handling of the water. Sprinkler systems are being installed on lands where the characteristics of soils and topography make this method the most practical. Improvements of these types are needed on about 2,584,000 additional acres of irrigated land.

Improving trunk line systems is an effective way to increase the irrigation water supply by reducing transportation losses. Many canals and laterals require relocation or rehabilitation. Seepage losses in these trunk line systems frequently far exceed the amounts of water delivered to the land to be irrigated. These seepage losses are frequently primary causes of severe drainage problems existing or developing on irrigation projects. Trunk line systems needing improvement affect an area of about 1,105,000 acres.

Developing irrigation facilities to provide water for new lands

and to supplement supplies for some of the older irrigation developments will permit more intensive use of large areas of agricultural land. Flood waters and other surface runoff not now used can be stored in reservoirs. Canals and diversion and control structures will be required to convey these waters. One of the primary sources for water to be developed for irrigation is ground water which can be utilized by developing springs, by drilling into and developing artesian flows and by drilling and pumping from wells. Small flows may be utilized more effectively by discharging them into small reservoirs for overnight or short period storage thus making a larger flow available for a more efficient and shorter period of use. Further, groundwater drainage from irrigation projects frequently can be intercepted or pumped to provide dependable supplies on other lands. The number of these facilities needed in the Columbia Basin Area is estimated in excess of 18,000.

New farm irrigation systems to distribute water on lands to be brought under irrigation are important to the rapid expansion of irrigation. These systems should be designed with regard for the characteristics of the available water supply, the topography, soils and the crops to be grown. They should be planned before the farm development restricts design and to permit appropriate land preparation.

It is estimated that 18,800 new systems will be required within the next 20 years on the additional lands that will be brought under irrigation.

Practices to Improve Drainage

The humid parts of the basin area contain about one-half of the acreage which needs improved drainage. In the Willamette Valley, for example, it is estimated that production could be increased appreciably through improved drainage on approximately 600,000 acres, about 90 percent of which requires subsurface drainage. The Oregon coastal valleys contain about 100,000 acres of cropland and the coastal and Puget Sound valleys of western Washington about 300,000 acres which would be benefited significantly by improved drainage. In northeastern Washington and northern Idaho about 50,000 acres of cropland are too wet. There are about 100,000 acres, principally in western Oregon and western Washington which require diking for protection against high tides or high river stages.

Drainage improvements are required to remove excess water from the land to permit early working of the soil in the spring and to maintain favorable moisture conditions for plant growth. They include tile drains, open ditches, beds, dikes and diversions or combinations of these practices.

Drainage problems in areas where irrigation is extensive are, for the most part, subsurface problems concerning physiographic areas rather than individual farm units. Drainage improvements under these circumstances must be of an area type and can be planned effectively only after thorough consideration of natural physiographic units which are often valley-wide in extent. The necessary measures are of two general types; those designed to intercept surface and subsurface waters at points where they can be carried away without contributing to the

damaging high water tables; and those designed to lower existing high water tables.

The first type usually requires large open drainage ditches or closed drains located at appropriate depths in strategic places where incoming waters can be intercepted. The second type requires a system of open ditches or tiles properly spaced with gravity outlet systems or pumping systems to raise the water to the ground surface where it is carried away in surface drainage ditches or used for irrigation.

Drainage improvement measures of these types are needed on about a million acres of land in the irrigated sections of the Basin. The irrigation of additional large acreages of land, as is proposed, will probably result in more land requiring drainage improvements.

It is estimated that 13,600 miles of open ditches and pipe lines will be required as community systems to dispose of water accumulated by individual farm drainage systems where natural outlets do not exist.

Miscellaneous Practices

Correcting soil salinity is an urgently needed measure on a considerable area. Salinity as used here refers to excessive accumulation of soluble salts (saline soils), excessively high exchangeable sodium (alkali soils) induced by present or past accumulations of sodium salts, or a combination of these two conditions. Alkali soils may also form when irrigation water with a relatively high concentration of salts is used. Correction of these conditions involves establishment of good drainage, use of amendments to bring about replacement of the excess exchangeable sodium of alkali soils with calcium, and leaching by flooding to remove excess salt. Practices to improve soils structure

must be used to the maximum to maintain permeability. There are about 445,000 acres of land requiring treatment for correcting soil salinity or alkalinity.

Farm ponds are needed to provide for fire control, stock water and supplemental irrigation. Some ponds are suitable for stocking with fish and provide wildlife habitat. Approximately 14,500 ponds of this type are needed.

Improving wildlife areas for game species on agricultural land requires consideration of the food, water and protection requirements of the game. Fencing is one of the most important methods of improving wildlife areas. The exclusion of livestock from springs, farm ponds and marshes assures more usable areas for upland game, furbearers, and waterfowl. Also protected odd areas, field corners, farm ponds, and gullies retard erosion and assure cover and food for pheasants, rabbits, quail and other game species.

All wildlife areas should be guarded against fire and unwise use of chemical sprays for weed control. Food habit studies show that herbaceous plants and shrubs contribute much of the food for most wildlife species found in agricultural areas. It is estimated that about 202,400 acres should be improved for wildlife use.

Cleanup clearing is required on sagebrush and stump lands to permit the most effective use of the land for agricultural purposes. It is estimated that this measure should be applied to about 365,000 acres.

Fire protection for crops and farm plant facilities is a primary requirement for successful management. Little cropland need actually

be devoted to fire protection other than fire lines around grain and pasture lands when the vegetation is easily burned. Permanent tree plantings should be protected by fire lines whenever necessary.

Protection from fire becomes primarily a matter of education about the farm, and in identification of fire hazards and how to remove them. Group and community action for fire protection can be accomplished by organizing and equipping rural fire protection cooperatives or districts.

Benefits of the Cropland Program

The cropland program outlined will result in many benefits. For example, improved cultural practices together with proper land use will bring about a material reduction in erosion and runoff. This means reduced damages from floodwater and sedimentation. Crop yields will be increased or at least maintained at their present levels. Increased amounts of food, fats and fiber will be available to help meet the demands for a constantly increasing population. The cropland program is a dynamic program, designed to achieve full economic use of the basin's cropland resources in time of peace or in time of national emergency.

Illustrative of the conservation benefits resulting from the recommended program is the estimated increased production of major crops over those which would prevail without a conservation program. Assuming, for the purpose of illustration, that present cropland acreages would not change, it is estimated that the average annual increase in production of wheat would be about 23,100,000 bushels; of oats about 3,900,000 bushels; of hay about 1,275,000 tons; and of

potatoes about 425,000 tons. While detailed analyses have not been made for all crops, it is believed that increased production of other crops would be substantially similar.

Rangeland

Problems relating to rangeland in the Columbia River Basin Area are many and concern both technical and management aspects of rangeland use. They are important problems because about 123.5 million acres of public and private lands are involved. Rangelands are located in all physiographic provinces of the Basin Area and are affected by many divergent conditions brought about by climate, soils, ownership, use, fire and others. The basic problems are not always important area-wide. Specific problems may be of major importance in one physiographic province, but of less or minor importance in another. An example are problems concerning big game.

Problems of Multiple Watershed Uses

Multiple use on rangelands is rapidly gaining wide recognition. Many areas are being used for livestock grazing, big game habitats, timber production, water source areas, and recreation sites. Many of these uses impose a different management pattern, one frequently conflicting with the other. Such multiple uses are often the primary causes of some of the problems to be mentioned later in this report. Decreased forage production is the basic result of current problems area-wide. While forage production on forested and non-forested ranges has improved from a low several decades ago, it still is the one of serious concern to the range user and manager, whether land

ownership concerned is private and public. Production on a large part of the total range is in unsatisfactory condition, generally referred to as poor. Many causes and events have brought about this condition. The primary causes that are still current and deserve additional attention are: Ownership pattern, inadequate use of existing information and research data, inadequacy of fire control, summer and winter game range, brush invasion and control, water supply, range rotation and rest periods, stocking rates, forage depletion, and withdrawal of range areas for other uses, such as reclamation projects, national defense projects and conversion to grain production.

Over 4 million acres of cropland in the Columbia Basin Area are dependent on irrigation water produced from watersheds grazed by livestock and big game. Denuded watersheds seriously affect water retention and rate of annual and seasonal flows. Steep watersheds having light or coarse textured soils are subject to high silt and debris production, and are particularly subject to instability when vegetation is abused. Such silt and debris sources can and are causing heavy damages to canals, reservoirs and other improvements.

Commercial timber stands occupy about 26 million acres of grazed rangelands. Watershed and timber values in many cases exceed the range forage value for livestock. Forage growth and utilization affect timber regeneration and growth. On both public and private range lands correlation of timber production and forage production is inadequate. Recreational values are high in some parts of the forested range areas, particularly in the Wallowa Mountains, and the west slope of the Rocky Mountains. Grazing should be excluded from

some recreational areas. Greater attention should be given to grazing effects upon fish propagation. In many areas, particularly where water sources are small streams, grazing is detrimental to fish life through trampling of spawning grounds, bank trampling and elimination of good bank cover.

Mining enterprises, principally placer and dredging, have adversely affected or destroyed substantial areas of high producing meadow and mountain valley range areas. Provision for restoration of these areas into high forage producing areas presents a problem involving legislation and economics.

Big game consume 15 to 20 percent of the forage produced on rangelands in the basin area. About 30 percent of the forage on the forested rangeland areas is utilized by big game. The remainder is used by livestock. On many ranges suitable for fall and winter use all or nearly all of the forage is required for winter use by big game. However, in many areas fall and winter big game ranges are almost denuded of vegetation by livestock prior to the movement of big game from summer habitats to fall and winter grazing areas. During the winter most big game occupy fringe areas at the foot of high mountains and above valley floors as winter survival areas. Encroachment of irrigation farming, dry farming and fenced pastures into the upland areas the past quarter century has seriously diminished big game fall and winter ranges.

Ranch operators, game supervisors and others often do not recognize the quantity of forage that must be made available on both summer and winter ranges if big game are to survive in reasonable numbers.

Further attention and study should be made to correlate desirable and practical game numbers consistent with available summer and winter use with respect to the local livestock economy, special hunting seasons, etc. This involves cooperation and understanding between local sportsmen's organizations and state and Federal agencies concerned. With the exception of a few areas, supplemental feeding is not an answer to overstocked winter game ranges. The big game range is a year-long range; the forage must be available or the game will die.

Principal game problem areas exist on the east slopes of the Cascade mountains, north central Oregon, western Montana, western Wyoming, and southwestern Idaho.

Ownership Problems

Ownership patterns in several parts of the area conflict with good range use. Checkerboard ownership presents serious problems, particularly in the Snake River Plain, Harney Basin and Ochoco-Blue-Wallowa Mountains provinces. Interspersed private and public lands prevent improvement programs from becoming effective. Fencing cannot be economically accomplished when this pattern exists. Rodent control is not effective unless done on all adjacent lands. Fencing of one ownership precludes stock from adjacent areas using natural watering places. Reseeding developments cannot be successfully carried out unless the seeded area can be protected (by fencing) during the establishment stage, and from livestock and rodents from adjoining lands.

A common period of use, preferably the one permitting resource perpetuation in as good or in an improved condition, is quite impossible because of divergent interests and forces affecting all private and public interests. The marginal operator, usually facing short feed reserves in early spring, is anxious to be on the range even when great damage may result from trampling in wet ground, and before the desirable plants have opportunity to build up their winter depleted root food reserve so essential to perpetuation of desired species.

Private and public land operator and management interests have and are making serious efforts toward solution of the intermingled private-public rangeland problem in the interests of range improvement on both kinds of land, but so far little tangible improvement has been made.

Protection and Management Problems

Inadequate use of existing information accumulated by progressive rangeland operators, local, state and Federal agencies, is a problem being met with some success in recent years, but requires additional means of establishing cooperative efforts, dissemination of information, and means of gaining acceptance of proven techniques. Federal agencies and state institutions have developed or introduced many new strains of grasses and legumes, which are better adapted for range improvement. New methods of range improvement through reseeding and management are practical and economically feasible; however, their acceptance has not been widespread.

Much information is available by merely observing practical methods of reseeding and management practices being carried out by progressive ranch operators. In most instances these operators are cooperating with some state or Federal agency, or both, and are very cooperative in assisting and advising others. In other cases, state and Federal research stations have plots and demonstration pastures where the results of various measures and management practices can be observed. In many localities large operations areas, particularly Federal, such as on national forests and land utilization projects, provide "show windows" where practical range improvements used by adjacent stockmen provide excellent demonstrations.

Much variation exists in the various physiographic provinces and adequate research facilities are not available to investigate all the situations affecting range vegetative improvement and management. The economic aspects of range improvement have had only minor research attention.

Inadequate fire control on both private and public ranges results in great loss of annual forage supply, fences, buildings and further deterioration of the physical rangeland conditions. In addition to the loss in forage values many fires result in accelerated erosion, making range restoration more difficult, and in silting of ponds, reservoirs, canals and highways.

Range fires are caused by carelessness of the general public and lightning. Most serious fires on private ranges are caused by carelessness or intentional burning, while most fires on public lands, generally less accessible to the public and at higher elevations,

are caused by lightning, although carelessness by campers, fishermen and others cause numerous fires.

By and large, inadequate fire detection and control is most serious on private rangelands because in most cases there is no organized detection and control system. Private ranges generally occupy the lower ranges which are bisected by highways and railroads, and are subject to concentrations of sportsmen such as upland game bird hunters. Private ranges, for the most part, lie at lower elevations and have higher temperatures, low relative humidity, and lower rainfall resulting in a long period of high inflammability. Sustained poor use and fires on most of these lands have resulted in marked, and in some cases, total loss of perennial vegetation. Annual vegetation, predominately cheat grass, is highly inflammable throughout the late spring and summer months.

Fires on low, dry ranges, whether on private or public lands, are a constant serious threat to higher adjacent rangelands which are often forested. Hot, dry winds often carry low range fires into upland ranges in a very short time and before organized efforts, if any are locally available, can begin to cope with the problem. Such fires have been known to sweep through several ranches and over miles of open rangeland in a matter of minutes, denuding the land of vegetation, destroying fences, buildings, equipment and adjacent ripening grain fields. Such fires occur frequently on, but are not limited to, the Snake River Plain.

The prevention of range fires involves problems in public education, development of local organizations to prevent and control fires,

development of special equipment, and recognition that properly improved and managed ranges are less subject to fire hazard than are poor, rundown ranges.

Withdrawal of rangelands for other uses have in many instances caused further concentration of livestock on other ranges already over-used, and brought lands under cultivation which cannot be economically cultivated for continuous use without destruction. For the most part lands converted to crop use have been used for grain production under the wheat-fallow system. Small acreages have been placed under private irrigation systems. In many cases such lands are shallow, rocky or otherwise unsuited for crop production.

During and after both World Wars vast acreages of rangelands were converted to crop use. Following the first World War after being sown to grain several seasons, frequently resulting in total crop failure, the lands were abandoned. Sagebrush and other low forage producing and less palatable plants invaded, making redevelopment of the lands for range use uneconomical. Broken down fences in many instances continued for many years to be a serious hazard to livestock. Present indications are that the conversion of substantial acreages of similar lands from range to crop use during and following the second World War will create a similar problem.

Large acreages withdrawn for national defense installations necessitated heavier use of already heavily stocked adjacent ranges. Gradually some of the withdrawn lands are being released for grazing purposes.

Brush invasion and control is another serious range problem in

the Basin Area. Brush invasion has occurred on millions of acres, principally on the Columbia Plateau, Harney Basin, Snake River Plain, East slopes of the Cascade Range and West slope of the Rocky Mountains. Invasion of brush has been caused principally by overgrazing and fire. Following forest fires, brush rapidly takes over moist north slopes in mountain areas, to such a degree that little edible forage exists. Brush vegetation occupying moist high potential water yielding sites in mountainous areas transpire tremendous quantities of water otherwise available for stream flow.

On the plateaus and plains, sagebrush, rabbit brush and other non-palatable brush species have seriously invaded tremendous areas of private and public range resulting in seriously depleted grass stands. Effective and economical spray eradication methods have been only partially developed. Brush eradication methods by plowing, discing or beating are costly and only partially effective.

The history of water supply on rangelands is a romantic tale of the early West. It has often been said "who controls the water controls the range." The statement is still true. Bulldozers and well drilling machines have replaced the six-shooter, except in isolated instances, but available water within reasonable distances remains a basic rangeland problem. While many areas are more or less adequately provided with ample stock water from perennial streams or springs, about half of the basin area comprising southern Idaho, all of Oregon east of the Cascade Mountains and south central and southeastern Washington generally has inadequately developed water supplies on the ranges. The predominate need is on the plains and plateau

areas where the vegetation is principally grass, browse and brush. The need exists on both private and public land. Large areas of public land are almost wholly without developed water limiting their use to winter and very early spring. Many ranchers give inadequate consideration to ample stock water needs, and public agencies frequently do not have adequate funds to provide the needed developments. Lack of water in one area usually results in over-use of an adjacent area having adequate water. Many ranch operators recognize the need for additional water for economical, effective range management, but are financially unable to develop water facilities.

Season of use and stocking rates are perhaps the two most important range management measures affecting range condition.

It is important that winter ranges be used only during the dormant season, in order that new seedlings and seed germination can perpetuate the range. For the most part, winter ranges have been used too late in the spring, doing great damage to new plants.

Spring-fall ranges have been grazed too early in the spring before plants can stand heavy use and maintain vigor. Over-utilization in the fall period reduces plant vigor and seedling establishment. Since the period of succulent growth coincides with the period when heaviest damage can be done by over-use, it is not difficult to understand why spring-fall ranges have become so severely depleted. Summer ranges are generally in fair to good condition. This is due principally to location, usually high in mountainous areas, short season of use and higher growing season precipitation. Overstocking, regardless of season of use, is detrimental to range condition.

Results are loss of seed supply, trampling of organic cover and young plants, increasing erosion and runoff. Adequate application of these management measures will require intensive education, demonstrations and technical assistance.

Rotation and deferred grazing provides alternate rest periods every few years, or in some cases biannually permitting increased seed production and seedling establishment and general improvement in plant vigor. Alternate use of fall or spring periods, and deferment for whole grazing seasons is needed to improve range conditions on the vast majority of the rangeland. Lack of attention to these management practices has resulted in smaller livestock gains, reduced calf and lamb crops, reduced wool production, increased losses from poisonous plants, and higher unit operating costs. Considerable annual variation occurs in forage production, particularly on the spring-fall ranges. Limiting livestock numbers to an average annual carrying capacity has been a long standing problem.

Livestock distribution over the range to secure uniform grazing is a problem affected by water supply, topography, fencing, salting plans and financing needs.

Problems relating to noxious weeds, poisonous plants, rodents and diseases are covered in the section of this report dealing with problems affecting all lands.

Rangeland Program Objectives and Scope

Major objectives of the rangeland program recommended for the Columbia River Basin Area are: increasing forage production on both

forested and non-forested rangelands, and stabilization of the land to insure high yields of forage and forest products existing on these land in perpetuity. The program will be mutually beneficial to livestock interests, wildlife interests, water resource interests and interests of the general public through the conservation and preservation of the natural resource.

To accomplish these objectives the present productive capacity of rangeland in satisfactory condition must be maintained; depleted ranges must be restored to their highest economical productive potential, and satisfactory management practices must be applied for livestock, big game and other wildlife needs.

The non-forested range and forest lands yield a big majority of the stream flow so essential for irrigation, power, municipal and industrial needs. When range areas, either forested or non-forested, are damaged by misuse or fire, soil erosion, accelerated runoff and sedimentation immediately occur, with resultant damages to the adjacent and distant sites by sedimentation of roads, irrigation works, reservoirs and other public improvements, and flooding of small valleys and flood plains. The program will greatly assist in the prevention of flood-producing runoff and sedimentation.

To achieve these goals a program of conservation, development and use of the range resource is recommended which involves the following major phases: physical measures to improve and protect the land and its cover; practices to improve the management of livestock and game that use the land; protection of the range resources from damage by insects, disease, rodents, and fire; and technical and educational

services to owners and managers of rangeland.

Practices for Range Improvement

Seeding and planting of grasses, forbs, and shrubs are recommended as a means of restoring vegetation on range-watershed lands now producing far below their potential capacity. These practices will be applied only to lands so badly denuded of vegetation that natural sources of seed are lacking and where successful rehabilitation is reasonably assured. While the need is great throughout, it is especially urgent in the Blue Mountains of eastern Oregon, in adjacent Washington, and in southern Idaho. Although seeding and planting are needed to some extent on lands of all ownerships, need is greatest on the low-lying ranges.

Revegetation by reseeding and planting is an important flood and sediment control measure on many foothill and mountain lands where existing cover provides insufficient protection against accelerated runoff and erosion. Needs amount to 11,393,000 acres, of which 4,940,000 acres are public lands.

Removing unpalatable woody plants so that desirable herbaceous forage species can be established naturally or by seeding is needed at scattered locations throughout the basin. The work is especially urgent in the sagebrush zone of southeastern Oregon and southern Idaho. In the Snake River Plains the removal of sagebrush followed by seeding of grasses has increased forage production from 5 to 10 times depending on the condition of the unimproved range. Although some brush removal is needed on many rangelands, about half of the recommended

program applies to valley and foothill private rangelands, mostly with sagebrush cover.

Brush removal is needed on about 6,977,000 acres of land, of which approximately 10 percent is Federal land.

Diverting flood runoff from foothill and mountain lands and utilizing it to increase forage production on mountain meadows and low-lying rangelands is recommended mainly for privately owned ranges. Of the 620,000 acres where needed, 18 percent is public land, nearly all of which is Federal.

Fertilizing rangelands is needed in many areas at the time seeding is done. Where tests indicate fertility deficiencies exist, it is estimated that fertilizers are needed on about 5,591,000 acres.

Practices for Range Protection

Fencing is needed for both protection and management. Protective fences are for the purpose of withholding livestock from newly seeded lands for a 2- or 3-year establishment period and to exclude grazing on administrative sites, campgrounds, and other special use tracts. Management fences are needed to regulate use, to control livestock drift, and regulate stock movement in line with seasonal readiness of vegetation, and to break pastures and allotments into managerial units. About 5,600 miles of protective fences and 47,800 miles of management fences are needed, of which 30,700 miles are needed on public lands.

Poor balance of livestock numbers and forage production, together with improper seasons of use, is the most serious problem confronting range operators. To correct this situation, range revegetation with

temporary exclusion and deferred-rotation grazing are recommended. Practices aimed at building up and improving the carrying capacity of the range will require other sources of forage for a time.

Proper stocking, deferred and rotation grazing, and providing systematic rest periods for plants during the growing season are fundamental in perpetuating forage plants. This practice has been highly effective in maintaining healthy range conditions and in the restoration of depleted ranges. Deferred grazing is needed annually on 5,258,000 acres of rangeland.

A more intensified management program for livestock and big game is needed on both the non-forested and forested range covering 81 million acres.

Improving Range Management

The development of ponds, springs, and wells is recommended to provide water for livestock on insufficiently watered rangelands. On the spring-fall ranges, especially those in southern Idaho and southeastern Oregon, and on many summer ranges the number and distribution of stock watering places are inadequate, and livestock distribution is not uniform. The recommended program will lighten the heavy use near existing water and will make much presently unused forage accessible, thereby improving livestock distribution. Stock watering facilities are needed on lands of all ownerships, but the need is by far the greatest on the low-lying semi-arid ranges. The recommended program includes 31,600 ponds, 8,300 springs, and 2,500 wells.

Construction of driveways and driftways is recommended to move

sheep and cattle to and from ranges, and to make passages through dense or down timber which prevents livestock movement. Lack of these facilities is a major factor in poor livestock distribution and grazing use on many summer ranges. They are important on public ranges. About 4,700 miles of driveways and driftways are needed, of which 3,000 miles are on public lands, principally Federal.

The efficient handling of livestock on the range requires the use of structures such as cattle guards, loading corrals and chutes. These are needed mainly on the winter and spring-fall ranges of southeastern Oregon and southern Idaho. These measures apply to all ownerships, but the need is greatest on low-lying lands. Facilities needed number 6,700. In addition, salting plans are needed for all rangelands to aid in controlling livestock distribution.

Benefits of the Rangeland Program

The increase in forage production that could be gained by the rangeland program outlined is estimated to amount to 11.6 million animal-unit-months of forage each year, once the program reaches full effectiveness. This benefit is the total from the 123.5 million acres of non-forested range and grazed forest land. In terms of beef equivalent, the additional forage production and the more efficient use of all forage under the recommended program will amount to 373 million pounds annually.

Rehabilitation measures included in the program can accomplish more than the 70 percent increase in forage. Improved vegetation will increase soil stability and reduce erosion. Sediment from grazed lands

will be greatly reduced. Percolation of water into the soil will be improved, storm runoff will be lessened, and damaging flash floods will be less frequent.

Improvement of soil and cover and additional forage will result in increased stability for the range industry. More carefully planned management and use of the range will allow for variations in forage production caused by climate or other factors. Deterioration in soil conditions and the downward trend in productivity on the many millions of acres of range now classed as poor can be reversed. As the range is rehabilitated, the productive capacity of the soil can be saved and built up for the future.

Big game as well as livestock will benefit by the program. Better distribution of seasonal range and of use of the forage by domestic stock will reduce the present severe winter kill from starvation that has repeatedly cut down the deer and elk herds. Amounts of forage needed and taken by game animals have been considered in the program; certain measures have been included primarily for the game, to reduce their competition with domestic stock. Hunting will be improved to meet the increasing demand, and hunters will find game in better condition.

Forest Land

Timber is, and will continue to be, the major cash crop from the forest lands. However, the water produced as streamflow from forested areas, though it pays no direct return to the landowner, is of equal or greater importance. The expanding development of the Columbia River

Basin Area has been accompanied by an increasing demand for all forest products. This increase in demand has intensified the complexity of forest land management problems. These problems may be grouped into five broad classes: resource management problems, resource protection problems, land ownership problems, resource utilization problems, and a miscellaneous class including problems affecting all the above.

Management Problems

Uneven distribution of age classes of standing timber presents a serious management problem. For continuous production, the ideal forest would have equal areas of timber in all stages of maturity. Before the advent of the white man, the timber stands were composed largely of mature and overmature trees, with young stands in the minority. The past century of logging and frequent large forest fires has changed the picture considerably. Today, there still is a substantial acreage of mature timber and an extensive area of very young trees, but a definite shortage of the age classes between. To prevent a decline in timber production, the harvest of the mature stands must be spread over the period needed for the young growth to reach useful size.

As the old-growth timber stands are harvested, the source of high quality timber is diminishing. In part the tendency of young timber to be limby and of poorer quality for lumber or veneer products can be counteracted by pruning trees that will be held for the final harvest. Growing conditions can be improved and growth rates increased by thinning dense stands of young growth and by weeding out competing noncommercial trees.

Much of the mature timber is vulnerable to windthrow and attacks by insects and disease and needs to be harvested soon if its values are to be retained. Such a harvest job requires a complete forest transportation network. There are many large roadless areas, and one of the most urgent needs is to build a road network that will make flexible and adaptable management possible so that orderly harvesting can proceed in any area and natural losses be held to a minimum.

Large areas of forest land in both private and public ownership are poorly stocked. Trees must be put on the land, either by planting or seeding, to make use of the productive capacity. To do this, fire hazards must be removed, competing vegetation eliminated, rodent populations controlled, and nurseries built to produce seedlings for planting.

Protection Problems

In the past, protection problems have received the major share of attention, but there remains much to be done. Extreme fire hazards still exist in some areas, and the level of fire protection needs to be raised over most of the forest land. When weather is abnormally dry and windy, major fires can and do break out and destroy large areas of timber. Fire hazards along roads and in areas of slash concentrations need to be reduced, and snags need to be felled in old burns.

The various activities of management must be carried on so that they do not result in damage to the soil or to the streams. Access roads must be built according to specifications that provide for stable

location, adequate drainage control, and a minimum of soil disturbance. Timber harvesting must be planned to prevent equipment from doing damage to channels, to keep debris out of the streams, and to avoid excessive soil compaction or the creation of new drainage channels on the slopes. Recreation facilities should be developed with full provision for sanitation facilities to avoid possible stream pollution.

Ownership Problems

The ownership pattern on forest land also presents problems. The small size of many holdings is itself a deterrent to sustained yield management. Cooperative action is imperative in many phases of forest management and protection; fire, insects and disease take no account of property boundaries. Small intermingled parcels held by various owners make management less efficient for any of them. Blocking up ownerships is needed to improve management for both private and public owners.

Utilization and Other Problems

Utilization problems remain serious, although increasing demands for wood of all kinds have brought the less desirable species and the lower quality timber into wider use. There still are areas within the basin, however, where it is not considered economic to harvest any but the best timber. Waste in the forest can be reduced still further, and must be, if we are to reach full realization of the productive capacity of our timberlands.

Another utilization problem involves access roads and balancing the timber harvest by age-class and area. Over much of the forest area

of the basin, deep snows prevent winter logging. It is important to reserve areas accessible the year around for winter logging to minimize seasonal variations in employment and production. Many stands which should be thus reserved are being logged in the summer because of lack of access to stands which can be logged only in summer.

The problem of waste of wood both in the forest and at the mill is being attacked by development of equipment for handling timber more efficiently and by diversification in the wood-using industries. However, the lack of pulp and paper industries in the interior and eastern parts of the basin area is one factor which prevents making full use of the timber resource. Portable mills and logging equipment to handle small logs efficiently are needed. Conversion of mill waste to useful by-products has not yet reached a satisfactory level.

Progress of forest management has been slowed by tax structures which have led in the past to tax delinquency on cutover lands. Taxation procedures should consider the productive capacity of the land and the time required to grow a timber crop. Lack of forest insurance and lack of low cost forest credit are two more deterrents to owners. For the small owners, marketing problems present a strong handicap.

Though research has contributed greatly to the progress of forestry in the basin area, much remains to be learned. There are many gaps in technical knowledge throughout the entire field, from timber growing to utilization and economics. Too little is known about the interrelation of timber growing and watershed management, about the silviculture of some forest types, or about the effects of harvesting and slash disposal methods on the soil. Research also is needed on

the numerous problems involved in rehabilitation of once productive forest areas.

Forest Land Program Objectives and Scope

The principal objective of the forest land program is to develop and maintain on a sustained yield basis a forest cover that will help protect and regulate streamflow while producing adequate quantities and qualities of wood fiber, forage, wildlife, and opportunities for outdoor recreation. Meeting such an objective calls for sustained annual production of three billion cubic feet of usable wood fiber, including fourteen billion board feet (International rule) of sawtimber. It requires also the application of multiple-use management to all forest lands insofar as compatible with the production of wood and water.

A wide variety of measures are needed to make management more efficient, to provide recognition and facilities for all the forest uses, to balance the timber harvest between old growth and young timber stands, to open up areas now inaccessible, to reduce fire, insect and disease losses, to rehabilitate areas damaged by overcutting or fire or erosion, and to correlate management efforts guided by research and sound planning which must be in harmony with long-range needs. These measures are grouped into three major classes: those dealing with forest regeneration, those dealing with timber stand improvement, and those dealing with forest protection. Facilitating and management measures will be dealt with in a later section covering all types of land.

Forest Regeneration Measures

Planting and seeding timber trees and associated measures such as rodent control make up the regeneration program and are needed on 7.36 million acres. This work will provide cover on nonstocked areas and will complete the stocking in thin stands. Before any trees can be planted in some areas, brush competition must be reduced. In other cases where direct seeding is to be applied, rodent populations must be decreased. More seed must be collected from the faster growing and more disease-resistant strains of forest trees; and nurseries must be expanded to grow more seedlings.

Areas to be seeded or planted have been chosen on the basis of their high potential productive capacity, their importance to industry because of accessibility, or of their importance in storing snow, regulating snowmelt rate and streamflow peaks and in stabilizing soil. Most of the regeneration work is needed within the two major commercial timber types, the Douglas-fir and ponderosa pine. Of the total area needing this treatment, there are 3.27 million acres in Washington, 3.24 million in Oregon, 0.57 million in Idaho, and 0.28 million in Montana. The greatest part is west of the Cascades.

Though forest survey data indicate nearly ten million acres of forest land to be denuded or poorly stocked, it is believed that some of these areas can be brought back into production by natural means aided by good management and adequate protection. Future planting requirements arising from the continuing timber harvest, fire, insect attack, or other causes will be taken care of currently by the continuing annual program. Planting and seeding where needed on freshly

cutover lands in federal ownership is now handled as a part of the timber harvesting operation. In future it is assumed that this practice will be extended to all lands. In many cases natural regeneration is rapid and sufficient, but it is not always dependable.

Stand Improvement Measures

Timber stand improvement measures, including thinning, weeding, stand release, pruning, and controlled burning, apply both to natural stands and plantations. This work will increase growth rates, improve timber quality, and facilitate regeneration. It is needed on 6.99 million acres over the basin.

Many potentially high producing areas are supporting young forest stands which have become stagnated because the trees are growing too close together. Thinning is needed to increase the growth rate. Pruning is needed in a considerable area of potentially high quality young timber now in the limby, small pole stage. The future production of quality timber is dependent upon pruning because of the dwindling reserves of virgin old-growth timber which until now have provided the high quality products. Controlled burning is still another stand improvement measure which can be applied in certain cover types and stands. Wherever applicable it is usually an economical way of reducing ground competition, ridding areas of undesirable growth, and preparing areas for natural reseeding.

It is presumed that when the backlog of stand improvement work is accomplished any recurring future needs will be cared for currently in conjunction with management and utilization. There is practically

no stand improvement work being done at the present time except that which is being accomplished concurrently with or immediately after timber harvesting. So far, what has been done has been applied largely to the ponderosa pine type. Under the recommended program, however, nearly 30 percent of the work will be done in the Douglas-fir type.

Forest Protection Measures

Forest protection is vital to sustained forest resource production, to erosion control, to regulation of streamflow, to prevention of excessive sedimentation and the allied impairment of water quality, and to lasting scenic and recreational enjoyment. Fire is potentially the most devastating of all natural enemies of the forest, and present fire control organization and effort come the nearest to being adequate of all protection measures needed.

Fire protection is a major need on most of the forest and rangeland area. Present works and organizations must be expanded to afford the level of protection the forest and range resources warrant. With a growing population and increasing use of and demand for the timber, water, forage, wildlife, and recreation resources, the value placed upon these resources is increasing. But the greater the use, the greater the threat of fire, for most of the forest and grass fires that occur are man-caused. In less accessible rugged high mountain areas lightning fires are frequent and present another problem.

The protection program includes such things as erection of lookout towers, clearing firebreaks, felling snags, disposal of slash and debris in high risk areas, development of water supplies, and construction

of buildings for guards and suppression crews. Lookouts are needed to improve coverage of forest areas and to speed up detection of fires while they are small. Clearing firebreaks is necessary to provide quick access, to break up areas of fuel, and to furnish lines from which fires can be fought. Opening up springs and seeps, building ponds and tanks, and clearing trails to streams and waterholes for tank truck is also needed to improve fire suppression. Guard stations and suppression crew dormitories, warehouses and equipment depots are necessary in some of the less accessible areas, in order that men and tools may be available quickly when fires start.

The greatest amount of work is needed for hazard reduction and firebreak clearing in the heavily forested areas of western Oregon and Washington, northern Idaho, and western Montana. Disastrous fires occurred in these areas in 1931, 1933, 1934, 1939, 1944, and 1951. Fires will continue to occur in times of critical burning conditions unless the hazard is greatly reduced.

Total cost of the fire protection program is estimated at 50 million dollars for installation. Distribution of the recommended measures will be over an area of 100 million acres, 66 percent to federal, 26 percent to private, and 8 percent to state lands.

Benefits from the Forest Land Program

The program described to meet the needs will make use of the full potential productive capacity of the forest land. Total wood production will be increased more than twice to meet the continuing demand and will be maintained at the new high level. In terms of sawtimber

only, the benefits will ultimately reach an additional 6.47 billion board feet (International rule) annually.

Thousands of acres of land now barren and denuded or invaded by brush and bracken fern will be put to growing trees again. Some of this land has been out of production for as long as fifty years, and some of it represents the best timber growing sites. This is land that was devastated by the great fires of earlier decades, or that was once cleared for farming and found uneconomic for such purposes.

Quality of the timber will be improved by thinning and pruning and by selection of parent trees for seed. Though we may never again reach the volume of high quality production that characterized the cutting in the old-growth forest until recently, we will obtain through careful management better quality material than is now being taken from second-growth stands.

Since the forests of the Columbia River Basin Area produce a large share of the nation's timber, the benefits are more than local. Both within and beyond the basin boundaries, assurance of continuing supplies of timber will stabilize industries and communities. Logging towns will no longer become ghost towns, as many have in the past. Improved utilization will be accompanied by increased diversification, creating further stability. Greater protection of the forest resource against fire, insects, and disease will better preserve the timber supply, reducing present losses by three-fourths. It will thus make more timber available for use, and will protect the investment of the whole wood industry.

Even the forest management and protection organizations will

benefit, by reason of reduced fire suppression costs. Such costs now average about $5 million annually; it is estimated that they will be cut in half. Other uses of the forest will also benefit, with reduced fire losses to recreational developments and to forage for game and livestock. With less burned area, there will be less ash and erosion sediment threatening water quality or silting up downstream water storage and diversion works.

Operations and management on forest lands will receive a significant benefit from the program. Planning and work will be concentrated on current--and largely foreseeable--needs. Improved access and communications will simplify and speed up all management activities. These and other management aids are considered in a following section, as applicable to all types of land; but their benefits to the forest are considerable.

Physical Programs Affecting all Classes of Land

Included here for the sake of convenience are those measures or groups of measures that are not limited in application to any one class of land. These measures are needed on all classes of land, and would apply without any distinction as to class or use. They include the control of weeds, eradication of poisonous plants, reduction of insect and rodent populations, combating plant diseases, improvement of fish and game habitats, and development of recreation areas and facilities.

Weed Problems and Control

The Columbia River Basin Area is threatened by the spreading of

numerous weeds which cause considerable loss in crops. Such extremely harmful weeds as Canada thistle, morning glory, white top, Russian knapweed, and quack grass are well adapted to cropland conditions within the Columbia River Basin Area. These plants also grow well on the ranges and other non-cropland areas which serve as sources of reinfestation for cropland. Waterways serve as a means of spreading seeds of noxious weeds growing along the banks. Aquatic weeds quite often reduce the capacities of canals for delivering irrigation water.

Noxious and poisonous plants and dense stands of undesirable vegetation create a basin-wide problem on the rangelands. Some plants such as big sagebrush and rabbitbrush are relatively unpalatable and obstruct grazing use and range revegetation. Others such as larkspur, deathcamas, halogeton, and sneezeweed, are poisonous and cause livestock losses.

An adequate research program is needed to develop sound control measures. An effective educational program is needed to stimulate concern and interest on the part of landowners and operators to put into practice recommended control measures. Legislation may be needed to permit establishment of weed-control organizations to control weeds on public lands.

Weed prevention is a major part of weed control. It requires an educational program to acquaint landowners and land managers with weed problems and weed damages and methods of avoiding them. Local legislation to regulate sale or transportation of materials contaminated with weed seeds may be desirable. Adequate sources of clean crop seed are always necessary.

Since many serious weeds are already established throughout the basin, control measures must be initiated and continually applied to check further spreading and to reduce existing infestations. The control program must apply to all lands, and must have the support of all landowners, private and public.

The control measures to be used for weeds depend upon the weed species, the extent of infestation, the location, and the land use. The general control methods which may be used are clean cultivation, soil sterilization, selective and non-selective sprays, biological, mowing, and burning. It is estimated that about 697,000 acres of weed-infested cropland should have intensified weed-control practices applied to them. At present these lands cannot produce high crop yields in competition with the weeds and are a source of infestation for other lands.

On the high summer ranges, control is needed for larkspur, death-camas, and sneezeweed. Adjacent to farmlands, control is needed for Canada thistle and whitetop. There are also severe infestations of halogeton in southern Idaho and of St. Johnswort in northern Idaho and eastern Washington that need immediate attention. For all rangelands, it is estimated that weed eradication is needed on 4,488,000 acres.

Insect Pest Problems and Control

It is conservatively estimated that harmful insects reduce the total agricultural production of the area by 10 percent. Some act as carriers of serious human, animal, and plant diseases, while others cause damage by contaminating or destroying farm produce. Fruits,

vegetables, seed crops and livestock are particularly vulnerable to insect attack. Insects often are a major contributing factor to poor range conditions where heavy infestations consume forage badly needed by grazing animals.

Many crop plants are attacked by such insects as aphids, grasshoppers, cutworms, leaf hoppers, and root maggots. Orchard trees and fruits are attacked by codling moths, leafrollers, and scale insects. On the rangelands, Mormon crickets, tent caterpillars, and grassbugs have weakened and reduced the density of desirable forage plants.

Insects present a constant threat to the forests. Leaf-eating insects such as the tussock moth, the hemlock looper, and the spruce budworm, various beetles that feed on the inner bark of the trees, and numerous wood-borers cause serious damage to timber by weakening or killing the trees. Annual timber losses by insect damage may equal the losses caused by fire.

Populations of insects may be kept under control in various ways. Crops in good growing condition are resistant to some insects. Soil sterilization by proper cultivation removes some pests. Others must be poisoned by the application of sprays and dusts. While these control measures are now being carried on over the entire area, it is estimated that intensified insect control is needed on 1,419,000 acres of cropland and 10,223,000 acres of rangeland.

In the forests, wherever insect infestations begin building up to epidemic proportions, emergency control measures are necessary. Leaf-eating insects are fought by spraying, bark beetles and wood-borers by spraying or by harvesting infested timber. Only recently have control

efforts made significant headway. Most of the control so far has been provided by winter kill, fire, predators, and other natural factors. The most important single element of the control program is completion of an all-purpose road system. Insect infestations are controlled with difficulty once they reach epidemic proportions, and control action must aim at prevention of epidemics. This can be done most readily with a transportation system that makes all forest areas accessible for the control of incipient outbreaks and the removal of damaged timber.

An insect-control program is needed on 3.15 million acres of forest land. Needs are greatest in inaccessible areas and in overmature stands. This represents the minimum acceptable control of known and estimated future infestations until susceptible stands can be cleaned up and control measures become a part of recurring forest management programs. It is not intended to cope with large-scale disasters such as the Douglas-fir bark beetle epidemic now raging over western Oregon forests. Such occurrences cannot be foreseen and must be handled as emergencies, though the program is expected to reduce their frequency and size. As soon as the forest stands are renovated, it will be possible to maintain adequate insect control at a reasonable annual cost and avoid the possibilities of devastating epidemics by means of continuous survey and prompt detection of attacks.

Rodent Pest Problems and Control

Many species of rodents cause damage to stored crops, growing

crops, range forage, and timber throughout the Columbia River Basin Area. Rats do the greatest harm, as they destroy huge quantities of foodstuffs, kill poultry, and carry various diseases. On both croplands and rangelands, mice, rabbits, gophers, and ground squirrels feed on crops and forage and upset irrigation and drainage operations with their burrows. Periodic high populations of such rodents require extensive control to prevent excessive damage.

Thus far, there has been no effective rodent-control program for forest lands. Porcupines, mice, and ground squirrels have increased to proportions where they are doing appreciable damage in some areas. Porcupines affect a large portion of the pine forests, gnawing the bark and girdling young trees. Damage by mice and ground squirrels is limited to plantations and reseeding areas where they eat the seeds and the tender tops of young seedlings.

There are about 1,693,000 acres of cropland including farmsteads, to which intensified rodent-control measures should be applied. Baiting with poisoned grain is the primary control method; but construction of rodent-proof buildings and storage facilities is important in reducing rodent damage. On rangelands, rodent control is needed on about 7,248,000 acres. On forest lands, local rodent concentrations need control over a gross area of 4,760,000 acres, in the neighborhood of young timber stands, plantations, and seeding areas where they are preventing satisfactory reforestation or are doing excessive damage to timber.

Plant Disease Problems and Control

Plant diseases caused by various fungi, bacteria, and viruses often threaten the success of farm and range and forest enterprises. The causative agents may be in the soil, airborne, or carried by insects. Plant diseases are expected to become increasingly serious as disease spread is made easier by intensified crop culture and increases in irrigated area. The success of individual crops may depend on the degree to which diseases are held under control. Entire crops may be destroyed or production greatly reduced if diseases are unchecked.

Epidemics of smut or rootrot or blight may be brought on by unusual climatic conditions, and though local in extent often cause serious damage to crops and range forage. Diseases such as white pine blister rust, trunk rots, rootrots, needlecasts, blights, and cankers take a heavy toll of timber in forest areas. Mistletoe, though not in the class of the other disease agents, is particularly harmful in some ponderosa pine stands.

On croplands, plant diseases may be kept down by planting disease-resistant strains, by preventive spraying, by the use of certain crop rotations and cultivation practices, or by removal of alternate hosts for the disease organisms. In the forests, tree diseases may be prevented by keeping the stands in thrifty growing condition, by thinning and salvage to remove trees weakened by crowding, fire, insect attack, or windthrow, by selection of disease-resistant strains for planting, and by removal of alternate hosts. The success of sanitation measures in the forest depends on adequate access and regular surveys for prompt detection of disease outbreaks. Restrictions on transportation of

infected plant material is another means of preventing introduction and establishment of disease.

Current disease-control programs on crop and range lands involve such measures as chemical treatment of seeds before planting, the use of chemicals for soil sterilization, regulation of irrigation, removal and destruction of infected plants, and the application of fungicide sprays to the growing plants. More intensive control programs are necessary, for despite current efforts, crop losses by disease are estimated at $20,000,000 annually in the Columbia River Basin Area. Success of these programs depends on the continued and increased cooperation of all landowners and operators.

On forest lands, disease control involves removal and destruction of infected trees, salvage of damaged timber, and eradication of alternate host plants. Management of the forests must be planned to include regular disease-detection surveys so that affected areas can be cut over and the timber salvaged. In the case of the blister rust which threatens to eliminate white pine completely, removal of the alternate hosts must be continued indefinitely, until disease-resistant strains of white pine are developed and established in the forest. Both control of forest tree diseases and salvage of damaged timber require an adequate road system for access.

Fish and Wildlife Habitat Improvement

The Columbia River Basin Area is richly endowed with a wide variety of game animals, fish, and furbearers. As population increases and the resources of land and water are more fully developed, the changes

will strongly influence wildlife. Coordinated land management that includes wildlife becomes more important, if old problems are to be solved and new ones are to be prevented.

Impounded waters upset fish and game habitats. Abnormal streamflow below storage reservoirs interferes with migration, spawning, and normal fish life. Construction of high dams blocks the migration of sea-going fish, denying former spawning grounds to them. Debris jams that result from logging and forest fires also block movement of fish. Diversions of water for various purposes affect the downstream passage of young fish to the ocean by reducing streamflow and by diverting the fish also. Mining and other industries have so polluted the waters of many streams that they no longer provide favorable wildlife habitat. Return flow of irrigation water raises the salt content of many streams. Ashes and silt from burned areas wash into the streams, poison the fish, smother aquatic growth, and bury gravel beds important as spawning areas. Removal of shade along streams by logging and fire affects stream temperatures. Erosion sediments from cultivated lands, overgrazed ranges, and forest lands disturbed by fire or logging change the stream habitat profoundly. Because so many streams have already been spoiled as wildlife habitat, it is imperative that waters that still provide good fish habitats be protected and developed.

Management of wildlife is difficult because of divided responsibilities. Many of the big game ranges and migratory fish spawning grounds are on federal lands. The habitat is managed by federal agencies, while the management of the fish and game is a responsibility

of the states. Conflicts between big game and domestic stock create problems. Large areas of big game winter range are privately owned; the animals eat stacked hay, damage orchards, and break fences, bringing many complaints from landowners. Other wildlife problems have been cited in the section on rangeland.

To improve game habitat and forage, cover and food plantings are recommended for 1.04 million acres, primarily on range and forest land. Grasses, herbs, and shrubs will be planted for cover and food for migratory waterfowl and upland game birds and for big game forage; and aquatic plants for fish and waterfowl. Nearly 5,400 miles of streams, and 38,730 acres of lakes are in need of further work such as clearing and cleaning, installation of dams and deflectors, and improvement of spawning grounds. Migratory waterfowl need sanctuaries and resting places; 235 water developments are recommended for this purpose. A total of 284 fish hatcheries and rearing ponds, mostly the latter, are needed to facilitate the propagation and distribution of game fish.

These projects are confined to public lands to meet the rapidly increasing public demand for fishing and hunting. About three-fourths of the work will be done on federal lands. By states, the work is distributed about 40 percent to Oregon, 33 percent to Idaho, 14 percent to Montana, 10 percent to Washington, and 3 percent to Wyoming.

Recreational Developments

Many activities are included in recreational use of the lands of the Columbia River Basin Area. The majority of use is by campers, hikers, picknickers, and tourists viewing the scenery in forest areas. But fishermen follow their sport in the streams on all kinds of land, and hunters pursue game on range and cropland as well as in the forests. Recreational use occasionally creates some conflicts with other uses, and certain problems have developed therefrom. With recreational use on the increase, these problems become more and more important.

In local areas of intense recreational use and development, grazing and logging are undesirable. Where scenic values are high, logging is detremental. On the other hand, recreational use and entry must be restricted on domestic water supply watersheds. The big problem, however, is keeping recreational developments up with demands. Many of these developments are necessary to control the use. For example, recreational use increases the likelihood of fire occurences; recreational developments are therefore placed where fire risk is low and suppression least difficult. With 24 million visits made in one year to national forests, national parks and monuments, and state parks, management of recreational use has become a big job.

To meet the demands of the constantly increasing throngs of recreationists, the program includes construction of various recreational facilities such as campgrounds, picnic areas, bath houses, and shelters, and the preparation of winter sports areas, organization campgrounds, hotel and summer home sites. A total of 34,606 such

installations are needed. Nearly all of the proposed developments will be on Federal land. By states, the projects are distributed 40 percent to Oregon, 25 percent to Washington, 23 percent to Idaho, nine percent to Montana, two percent to Wyoming, and one percent to Utah and Nevada.

Special Water Conservation and Flood Prevention Measures

Water is the most valuable resource produced by a large part of the watershed of the Columbia River Basin Area. Continued expansion of the agricultural and industrial economy of the area is largely dependent upon the development of this resource. Problems of floods, sedimentation of stream channels and storage facilities, seasonal water shortages, and water pollution have increasingly hampered development. These problems are the result of several basic causes.

Major Problems

The seasonal flow distribution of most streams is such that during the periods of maximum water requirements for agriculture and industry the flow is at a minimum; and the maximum flows not only are wasted but cause damages by flooding to agricultural, industrial and urban developments. This problem is being partially solved by public and private projects which provide storage facilities for some of the surplus waters which assist in flood control and make additional water available during periods of deficiency. Benefits from these projects accrue largely to downstream interests in the generation of power, water for irrigation and industry, and improved navigation on the Columbia River. These projects do not control the floods nor provide water to meet late season requirements.

Occupancy and use of the land are important factors related to water problems. Many farms, towns, and even some large cities are so located that they suffer flood damage during occasional high stream flow.

Improper treatment and inadequate management of the basin watershed lands are major factors contributing to its water problems. Water conservation and control is an inseparable part of good land management. Every use of the land - crop production, timber production, grazing, recreation, or transportation must be made with careful regard for this fact. Prevention of flood and sediment damages, maintenance of high quality water, and to some extent control of seasonal distribution of flows depend to a large degree on favorable watershed conditions.

Floodwater and Sediment Damages

Floodwater and sediment damages occur when channel, stream, or river capacities are exceeded and the excess water causes overland flow, inundation, erosion and sedimentation. In addition to the physical damages caused directly to property by floods, there are indirect damages which are losses resulting from the direct damages but not caused directly by the flood itself. Such damages include losses caused by interruption of service; the cost of evacuation and reentering premises made uninhabitable by floods; the costs of rescue work; the costs of caring for the sick and injured; the cost of traffic interruptions and rerouting; and losses of income.

Table 12 summarizes the average annual floodwater and sediment damages for areas that will not be protected. These damages are divided into two broad categories, agricultural damages and other damages.

Damages to agricultural lands, property and crops are caused by

TABLE 12. Average Annual Floodwater and Sediment Damages for Areas Unprotected by Authorized Projects, Columbia River Basin, Based on 1949 Prices. (Dollars)

State	Agricultural Damages				Other Damages					Total
	Flood-water	Sediment	Flood-water & Sediment	Subtotal Agricul-tural Damages	Transpor-tation Systems	Irrig. and Drainage	Urban and Indust.	Reser-voirs	Subtotal Other Damages	All Damages
Washington	2,727,600	1,440,500	366,300	4,534,400	2,567,500	513,400	15,000	133,200	3,229,100	7,763,500
Oregon	1,108,600	476,000	363,800	1,948,400	2,093,500	135,200	109,600	123,100	2,461,400	4,409,800
Idaho	817,200	239,900	66,000	1,123,100	852,700	268,900	453,200	252,100	1,826,900	2,950,000
Montana	235,900	4,000	38,700	278,600	411,200	2,600	26,900	20,300	461,000	739,600
Wyoming	25,000	5,200	10,100	40,300	16,600	13,300	1/	6,500	36,400	76,700
Utah	1,900	1/	100	2,000	700	1/	1/	100	800	2,800
Nevada	20,400	1/	400	20,800	8,000	15,500	1/	4,500	28,000	48,800
Total	4,936,400	2,165,100	845,400	7,947,600	5,950,200	948,900	604,700	539,800	8,043,600	15,991,200

1/ Data not available

water, sediment, and a combination of floodwater and sediment. These damages are largely associated with farm and ranch operations and occur primarily in cropland areas.

Floodwater damage is damage caused by physical contact with flood waters. Losses under this category include those of crop loss and reduced crop yields; damage to buildings, equipment, and fences; livestock losses; costs of cleanup and repair; and land loss by streambank erosion, major scouring and valley trenching.

Sediment damages are those damages resulting primarily from deposition of debris or sediment. They include such things as the deposition of sterile sands and gravels to depths great enough to remove the land permanently from cultivation, lesser deposition which reduces productivity and crop yields, flood-borne weed infestations, damage to buildings and equipment, and costs of cleanup and land relevelling.

Certain damages could not be divided between floodwater or sediment as to main cause and are set out in a combined floodwater and sediment class. It includes damages to reservoirs and major water distribution works; to farm irrigation and drainage systems caused by breaks, debris and deposition removal, and headworks dam or diversion replacement or repair; to farm bridges and roads; and to other types of improvements.

Other evaluated damages include a combination of floodwater and sediment damages, but not those generally associated with farming operations. These damages occur about equally on the various stream flood plains and on lands above the flood plains. Types of damage included were those to transportation systems, to irrigation and drainage systems, to urban and industrial developments, and to res-

ervoirs and stock ponds.

Transportation systems include all roads and trails on public lands, all other public roads or highways, and railroads. The types of damage covered were those of washout or breaks of roadbed or fills, scouring of or deposition in roadside ditches, loss or damage of drainage structures or facilities, sediment or debris deposition on roadbeds or rights-of-way, and other types of road damages.

Damages to irrigation and drainage systems include those to major distribution systems, diversion structures, or drainage systems serving more than one farm. The damages are over and above those tabulated under agricultural damages. The types of damage include system breaks caused by floodwater or sediment, damages to headworks or diversions, clean out costs for removing debris or sedimentation from canals, laterals, syphons, sediment basins or against tide gates.

Damages to urban and industrial developments occur almost wholly on flood plains of the various streams. Included are damages to or destruction of buildings or their contents; damage to public utilities such as telephone, telegraph, power facilities, streets, municipal water systems, and sanitation systems; clean-up costs; other urban damages; and damages to mills and log ponds.

Damages to reservoirs or stock ponds result primarily from sedimentation. Such damages include the loss of storage capacity, deterioration of storage water quality causing increased filtration or chlorination costs, loss of reservoir or stock pond facilities by breaks or washouts, and other damages.

There is also a miscellaneous category which includes all other

types of damages not considered under other headings. It includes a part of the damages to recreational facilities, to fish and wildlife, and various other damages which are largely intangible. In addition there is a sizable group of damages which is completely intangible. Though not evaluated in monetary terms because of their intangible nature or the extreme difficulty of evaluation, these damages are very real and their effects are widespread. They include the loss of life from floodwaters, mental distress caused by fear of floods, general fear or insecurity, sickness resulting from floods, disruption of communications, social and aesthetic losses and other losses having a bearing on the well-being of the community. Much of the loss in land productivity by erosion or deposition is also in this category.

Water Control Aspects of Land Treatment Programs

Several of the program measures needed for forest lands will produce benefits in terms of water conservation and flood control as well as in terms of increased timber production and other on-site benefits. Some of the measures would be applied primarily for their value in water conservation and flood control. Fire protection, for example, would be provided for noncommercial forest lands on watersheds where loss of cover would lead to destructive flooding or to impairment of water quality. Maintenance of cover will hold soil erosion in check and permit infiltration rather than rapid runoff of surface water.

Regeneration of forest cover on areas already denuded, whether by fire or other factors, is planned for watershed areas as well as for commercial forest areas. Of the 7,364,000 acres in need of tree planting, nearly all will provide water conservation and flood control

benefits, and a small but significant acreage is included for that purpose alone. Effects will vary according to topographic position and relation to flood damage areas.

Other forest program elements will show similar benefits. The disease and insect control measures will help accomplish the fire control objectives. The timber harvest, extending back into areas of heavy snowfall, will help control the catch and melt rate of the snow by controlling the size and location of forest openings and thinnings. Correction of present inadequate drainage facilities and stabilization of open cut and fill slopes along the access road system will eliminate a primary source of stream sediments and turbidity. Improvements in location and construction of future roads will avoid further trouble in this regard. Better care and supervision in logging operations will reduce soil disturbance, reduce erosion losses, permit greater infiltration, reduce surface runoff and flood damages, and help maintain water quality.

The same principles may be applied to the range program measures that serve to improve the plant cover. Seeding and planting grasses and shrubs will increase cover density, stabilize the soil against erosion, and promote greater infiltration of surface waters into the soil. Controlled grazing use through better management and closer supervision will make possible the rehabilitation of areas with scant cover and compacted eroded soil now contributing to flash floods and heavy stream sediment loads. Most of the needed 11,392,000 acres of seeding and planting, the 620,000 acres of waterspreading, the 5,591,000 acres of range fertilizing, and the various phases of man-

agement improvements will produce considerable reductions in streamflow peaks and in erosion and sedimentation. Again, some of these measures are needed for flood control and water conservation purposes alone, because of the great benefit to be derived therefrom. A further benefit from the improved management will be a reduction in the water pollution hazard, an important consideration in certain watersheds.

The installation of the measures and practices needed for cropland will be effective in increasing infiltration and the water-holding capacity of the soil reservoir. Cover crops, crop rotations and crop residue utilization are practices which achieve these effects by improving the structure of the soil. Terraces, subsoiling and contour cultivation mechanically increase infiltration by withholding the runoff waters and allowing a longer period of time for them to gain access to the soil reservoir. This increased retention of water in the soil reservoir reduces the amounts of precipitation lost to runoff and delays the concentration of the runoff waters that are not permanently retained by the soil.

In addition to reducing the flood peaks conservation farming reduces the damages that are caused by sedimentation, as a result of controlling erosion on the cropland areas.

Water Control Benefits of Land Treatment Measures

For each class of land, the effects of various needed program measures have been described in terms of infiltration, erosion, runoff, and sedimentation generally. By analytical methods which considered land use, land condition, rainfall, snowmelt rates, topography, and other physical factors, a more specific determination

of the combined program effects was made. It was found that the program would ultimately provide reductions in streamflow peaks ranging from five to thirty percent for various areas and conditions. Reductions are greatest in the smaller tributary watersheds, and on the more frequently occurring smaller floods. Some measures will become fully effective immediately; some will take a year or so, and others such as tree planting may require thirty years or more to reach full effectiveness.

The range program on the open rangelands of the central portion of the basin will provide reductions in local summer cloudburst flood peaks of 5 percent to 15 percent. Increased flood hazards will result from increased timber harvesting operations and land clearing if proper measures are not used to stabilize the areas affected. West of the Cascade Mountains the needed cropland and forest land programs together will prevent the more frequent flood peaks from increasing 20 to 30 percent. A little more than two-thirds of this reduction will be brought about by the forest program alone. In mountain watersheds east of the Cascades, the forest program will provide from five to twenty percent reductions in snowmelt flood peaks. Over the entire basin, as the measures become fully effective, the average reduction in flood peaks is estimated to be approximately 13 percent.

The fairly wide range in variation of the reductions cited is due to several factors. In some watersheds, conditions are still very good, and the program will provide but small improvement. In others, unfortunately the majority, conditions are less desirable because of past land abuse, and the program will provide marked improvement.

Without the program, with a continuation of present encroachment upon heretofore undisturbed areas and intensification of current activities, flood peaks may be expected to increase. The program will reverse this trend.

Reductions in sedimentation will also be provided by the program through the many measures that stabilize soil and prevent excessive erosion. Without the program, sedimentation is expected to increase. Similar to flood peak reductions, the effects on sedimentation will be variable. They are estimated by procedures similar to those described above, and range from 10 to 70 percent of the present stream sediment loads. Over the basin as a whole the sediment reduction will amount to about 26 percent. Sediment discharge of the Columbia River is estimated at 19 million tons per year, and the reduction will amount to 5 million tons annually.

Other benefits will be gained. With lower erosion on the slopes and less sedimentation and turbidity in the streams, water quality will be maintained at relatively high levels. Generally, the need for and cost of water treatment for particular uses will be reduced. Stream channels will furnish better habitat for fish life, with less danger of smothering eggs and fry in the spawning grounds, with fewer and less violent changes in the stream channels by flood action, with less debris contributed to channels by operations in watershed areas, with improved regulation and less wide fluctuation in streamflow.

Independent Structural Measures

The land treatment program needed will take some time to reach its full effectiveness in water conservation and control, and does

not include measures to repair past damages to stream channels; therefore various types of channel improvement of a structural nature have been added. These measures, including channel clearing, channel enlargement, channel alignment, revetments, riprap, jetties, lined channels, check dams, gully stabilization structures, diversions, floodwater storage dams, and sediment detention reservoirs, will supplement the land treatment program and provide immediate protection against local flood and sediment damages. As a further supplement, surveys to determine feasibility and physical characteristics of multiple-purpose reservoirs have been included, though construction of such projects is not a part of the proposed program.

This group of measures will be applied to flood and sediment damage trouble spots in the tributary areas. They are related to, but quite independent of, the measures described in preceding sections. Likewise, they do not conflict or compete with the major downstream river improvement works of other agencies.

Such structural measures are designed to provide for the orderly disposal of runoff by providing channels so that damaging flows can be conducted safely past vulnerable areas, or by a combination of reservoir and channel works. The structures or measures vary in size, emphasis and degree of control, depending on nature of the problems, flood characteristics, and local conditions. West of the Cascade Mountains a large proportion of the heavy precipitation occurs during the fall and winter seasons when frequent high flows cause damages, resulting in loss of soil, crops, livestock, other public and private improvements and human lives.

Streambed erosion is not a major problem in the small watersheds except in unusual circumstances. Roads and other encroachments on channels and clogged drainageways are common in the area and the flood relief measures are designed accordingly. In some cases, providing a channel capacity to accommodate annual or frequent flows will make some land available for more profitable agricultural use.

East of the Cascade Mountains most winter precipitation falls as snow which produces one or more high annual flood flows, following the spring thaw. Total precipitation is much less than along the coastal areas, but stream erosion problems are more acute. Tributary channels are relatively deep and channel capacities more nearly adequate for the more frequent flood flows. However, intense summer storms extending over relatively small areas may be expected in any part of this area. Such storms produced high damaging peaks on the local tributaries, and cause serious channel cutting. The major problem, then, is one of channel control, both grade control and bank control, as contrasted to the emphasis on water removal in the area west of the Cascade divide. The specific measures included in the program are grouped under five categories.

<u>Tributary channel improvements</u> include the installation of log, rock, piling, and other revetments, tetrahedrons, riprap and paving work, channel realignment and enlarging, and associated measures needed to control tributary streams in local areas, for protection of crops, other private and public improvements, and reduction of sediment production and sediment damages. About 8,350 miles of tributary channel improvement are needed.

Waterway stabilization and control structures have as their primary function the reduction of channel erosion. They include large check dams, diversion works, head controls and other measures to stabilize large arroyo-type gullies and stream beds. They reduce the velocity of water moving down the channel and have some effect on flood waters. They can be used often in combination with irrigation diversions where one structure will serve both purposes. In the basin, 781 such structures are needed.

Dikes and levees are earthen structures with or without riprap protection to be installed along streams to provide increased stream capacity and to protect land and property from flooding and damaging sediment deposits. When building dikes and levees excavated material is used to increase channel capacity beyond that obtainable by excavation alone. About 74 miles are needed along small streams throughout the Columbia Basin area.

Floodwater storage and retarding reservoirs will be installed to store, retard or detain excessive runoff from rain or melting snow. They are valuable in controlling flash floods from summer thunderstorms. All such dams will be earth fill construction from materials available near the site and equipped with adequate spillways and having ungated outlets with capacities limited to the capacities of the channels downstream. The construction of 29 of these structures is needed. They are all a part of the program for runoff and waterflow retardation and soil erosion prevention for flood control purposes recommended in the Boise River and Walla Walla River watershed survey reports.

Sediment detention dams are utilized to protect highly developed

areas or expensive improvements. They serve as debris basins or catchment areas and are used to stabilize placer deposits, provide a settling basin for upstream contribution of sediment, and catch the coarser materials being carried or moved in channels. Much of this debris moves down channels with runoff from high intensity or cloudburst-type storms. Such storms are frequent, are of limited areal extent, but are of unpredictable occurrence and highly destructive force. The basins are formed by building dams or levees in such a manner that a catchment area is provided. The outlet is protected with a permanent structure. The successful functioning of such a dam or structure depends on spreading out the flow and reducing its velocity and carrying power sufficiently to drop the coarse sand, gravel and boulders being carried before the flow emerges from the storage area through the protected outlet. Needs include the installation of 115 of these structures or dams. Many would be located at points where steeply sloping channels emerge onto relatively flat plains or fans. They are required for the protection of such areas as the apple orchards along the Columbia River, truck croplands in western Washington, and other highly developed areas subject to damage by debris.

Additional multi-purpose water storage structures are needed and the program includes recommendations for survey and investigation. In some watersheds the most practical control is to construct dams to store temporarily some of the excess floodwaters for later release at such rates not exceeding the capacities of existing or improved channels. These reservoirs can usually be designed for multiple-

purposes. Reservoir storage capacity has values for many purposes other than flood control. The storage of water for irrigation is important in the attainment of the full productivity of the watershed lands. Values for recreation and fish and wildlife provide additional justification for reservoir developments. Planning a reservoir development to satisfy only one need often complicates the later solution of the remaining water problems in the same area. The most efficient solution of all problems requiring water storage is to design projects which provide for all water needs in multiple-purpose structures.

In some instances the full storage capacity of a multiple-purpose reservoir might be used for flood control purposes during the period of usual flood hazard and also be used to provide the required irrigation water by storing the late season streamflow when the period of maximum flood hazard has passed. In other instances it may be necessary to provide design capacity primarily for the storage of irrigation water due to the inadequacy of streamflow to supply the irrigation water requirements during the period when no flood hazard exists. Hydroelectric power development and needs may also be considered. Provision for a permanent pool in the reservoir could be made in deference to recreational and fish and wildlife requirements. The separate solution of a single water storage requirement may not be economically feasible while the simultaneous solution of all the water storage requirements of a watershed, by use of multiple-purpose structures, may result in a very favorable benefit-cost ratio.

The total feasible program for multiple-purpose reservoirs was not determined due to limitations in survey resources. To determine and evaluate all of the physical and economic factors associated with

the determination of feasibility for all possible developments of this type would require many man-years of investigation and is not within the province of this report. Each possible development of this type should be investigated in detail as specific interest is expressed by those local groups that will benefit by its multiple-purpose functions.

West of the Cascade Mountains the full storage capacity of reservoirs can generally be used to control floods during the flood season and yet store enough water for irrigation needs from the late spring flows. In this area 382 sites are considered as having possibilities for multiple-purpose reservoir projects.

East of the Cascade Mountains there is need for additional irrigation water in most of the agricultural areas. Many of the smaller and a few of the larger irrigation enterprises have a serious water shortage during the late part of the growing season some years. In this area it would generally be necessary to store the water required for irrigation purposes during the flood season. Streamflow does not remain high enough thereafter to fill reservoirs for summer use. This requires that part of the design capacity be primarily for the storage of irrigation water and not for flood control purposes.

It was estimated that favorable sites and conditions could be found for about 1,009 multiple-purpose reservoirs east of the Cascades. Over the basin as a whole, it is estimated that surveys will be needed for a total of 1,391 such structures. Reservoirs would vary in size from a few hundred to several thousand acre feet of capacity. They would require dams of from 50 to 150 feet high which, in the majority of cases, would be of the earth-fill type. Although these structures

would be recommended by the Department of Agriculture following favorable survey findings, they might in many cases be built by other agencies.

Benefits of Independent Structural Measures

Several kinds of benefits accrue to the structural measures for water conservation and control. Immediate reductions in flood peaks, in sediment loads, and flood and deposition damages will be gained. Increases in water conservation will result by reason of improved low-season flow from the storage and gradual release of flood waters otherwise wasted. Greater availability of water will provide additional water for lands being irrigated with insufficient supplies, and for additional areas to be irrigated. Regular streamflow, decreased turbidity and sedimentation, and stabilized stream channels will improve the habitat for fish and riparian wildlife.

The value of these benefits is estimated to exceed the costs of the structural measures, and will for the most part be received over the period that is needed for the land treatment program to become fully effective. There will also be some residual benefits resulting from the structural program, over and above those benefits ultimately attributed to the land treatment program.

Illustrative of the physical benefits accruing from the independent structural measures is the reduction in the average annual floodwater and sediment damages. It is estimated that the independent structural measures, when installed, will reduce average annual floodwater and sediment damages by the following percentages:

Floodwater damages to crops and property	61 percent
Floodwater damages to land	60 percent

Sediment damage to crops and property	$22\frac{1}{2}$ percent
Sediment damage to land	74 percent
Floodwater and sediment damages to roads, bridges, irrigation and drainage systems and farm ponds	50 percent

In addition to the damage reduction, other tangible benefits in the way of increased crop yields, improved use of lands and enhancement of land and property values will result.

Facilitating and Management Measures

Administrative Facilities for Public Lands

The measures in this category include construction of access roads, trails, airfields, telephone lines, and buildings, and the installation of radio and other special equipment. The most needed single program measures and the one most essential to the development of the forest resource is access road construction. Many miles of road are required for adequate protection and management and for proper utilization of the forest. Private land road needs are not included because of their principal function is to facilitate private commercial enterprise.

Construction of some 38,802 miles of road is needed. One-third of this mileage is reconstruction. This does not include strictly timber utilization roads which will be built on public lands by the private operators contracting for the timber harvest. About 94 percent of the road building should be on Federal land, and six percent on state lands. Of the total mileage, 31 percent would be in Idaho, 23 percent in Washington, 27 percent in Oregon, 16 percent in Montana and three percent in Wyoming, Utah, and Nevada.

Primarily to help forest protection and management activities,

but also to improve recreational use, 27,582 miles of trail are required. Federal lands should have 96 percent of the trail construction, state lands 3 percent, and private lands 1 percent. By states, Idaho would have 30 percent of the total mileage, Washington 27 percent, Oregon 20 percent, Montana 15 percent, Wyoming 7 percent, and Utah and Nevada 1 percent.

Other transportation facilities needed to improve protection and management include 144 airfields and 3,277 helicopter landing spots. Ninety percent would be on Federal lands, six percent on state lands, and 4 percent on private lands.

Communication facilities also need considerable expansion to provide better protection to the forest resource. In consequence, there is a need for the construction of 6,215 miles of telephone line, the installation of accessory switchboards and other equipment, and the installation of 3,087 fixed and mobile radio units and repeater stations. Of the telephone mileage, 96 percent would be for Federal lands, 3 percent for private, and 1 percent for state lands. Radio installations are 74 percent for Federal lands, 17 percent for private, and 9 percent for state lands.

Buildings of various kinds are needed, both in remote locations and in communities with limited rental space available to attract and hold capable employees close to their work areas. Nearly 7,500 dwellings, offices, warehouses, garages, and utility buildings must be rebuilt or added to the present management plant. More than 4,000 water and sanitary systems need to be improved or developed in connection with the buildings. Ninety percent of these installations apply

to Federal lands.

In connection with recreational use on public lands, numerous cleanup and disposal projects are needed around campgrounds and scenic areas and along roads. Total cost of these projects amounts to 6.88 million dollars, 94 percent for Federal and 6 percent for state lands. The work would be distributed 45 percent to Idaho, 28 percent to Oregon, 15 percent to Washington, and 12 percent to Montana.

Management Aids

A phase of the program important to its final integration and success consists of the development of plans for handling the various resources. These plans must be long-term and comprehensive; and though developed separately for each resource or use, must harmonize all uses. Total area to be covered by the several plans amounts to 125 million acres, two-thirds of the Basin area. Costs are estimated at 23.3 million dollars; 91 percent Federal, 6 percent state, and 3 percent private.

Evaluation surveys are needed for checking on progress of the program and for keeping record of status. Included are such surveys as those on blowdown and insect damage in the forests, on tree disease outbreaks, on range condition, on forest tree growth, on game populations, on recreation use. These measures are included with the forest, range and other programs.

On all activities on public lands, both forest and range, the program calls for intensified management to protect and develop the forest, forage, water, wildlife, and recreation resources. This will apply to 90.3 million acres of land, and will cost an estimated

$14,325,000 annually.

Technical Assistance

Technical assistance to owners of the smaller tracts of forest land is necessary to enable them to get the greatest use and high production from their lands. The owners of the larger commercial tracts are now employing technical foresters, or using the services of consulting foresters, and the program does not contemplate direct public participation in providing technical assistance to such owners beyond the usual interchange of information and research findings. But 5,197,000 acres of the best forest land are in ownerships averaging about 160 acres each, and are not parts of self-sustaining commercial forest operations. It is to these that the program is directed. Proper management on these lands will result in public benefits in terms of increased timber production, reduction of fire, insect, and disease threats, etc. The program therefore provides for 70 foresters under the direction of the various state forestry departments to aid small forest owners. At present only about 15 foresters are so employed. Cost of this assistance is estimated at $530,000 annually.

Technical assistance to plan and supervise the installation of the measures and practices recommended for private cropland and rangeland can be obtained through soil conservation districts in a large part of the Columbia River Basin Area. Considerable progress is being made at the present time in the adoption of these conservation farming methods, but both public and private interests would be served by acceleration in the application of the needed program. As a larger part of the area becomes organized in soil conservation districts

and the people come to realize the advantages of the program more fully, a greater amount of technical assistance should be provided by the Federal Government to supply the demand.

Institutional Adjustments

The mixed forest land ownership and management pattern requires analyses and planning to unify management and utilization practices. There is need for some transfer of ownership through both purchase and exchange. Lands which can be properly managed and profitably retained in private ownership should remain there. Lands in need of rehabilitation and which cannot profitably be retained in private ownership should be in public ownership.

However, it is neither desirable nor practical to strive for good management and utilization through changing the ownership pattern alone. Of equal or greater importance is the need for a program of cooperative effort whereby all owners and agencies manage and utilize the forest and water resources of logical working circles or management units on a correlated sustained yield basis. There are two aspects of the management and utilization program wherein inter-agency cooperation and correlation of effort will be of utmost importance. These are distributing the cut of remaining mature timber over the period required to bring young stands into production so as to cause the least possible harm to local and national economy, and currently salvaging fire, insect and disease damaged timber so as to hold gross losses to a minimum.

There is also need of a program of consolidation of responsibilities, particularly Federal, in a few logical management units where duplication

of effort now exists.

To promote private forest enterprise to the greatest extent practicable, the forest tax, credit and insurance situation should be improved. The methods of taxation should be changed in most localities if forest lands are to be held in private ownership over the long crop rotation periods required to grow most commercial forest products. Credit extension in the form of low-rate, long-term loans is essential if any appreciable amount of devastated private land is to be rehabilitated and retained in private ownership. A program of forest insurance is needed to afford private owners protection against insect, disease and fire losses beyond a tolerable normal. Credit extension and forest insurance may result from some form of a cooperative program. The taxation program is a responsibility of the states and local government.

Legislative needs of the program include enactment of appropriate forest legislation where nonexistent, and strengthening of existing legislation where necessary so that minimum development, management and utilization practices are in harmony with long-range local and national requirements for forest and water resources. The states should be encouraged to handle the entire legislative program. The state legislative program should safeguard general public interests and welfare and thereby obviate any necessity for Federal legislation for that purpose.

Among the more urgent legislative needs are those for minimum forest cutting practice standards, minimum forest land cover requirements, minimum waterway channel and streamside protection standards,

including pollution and sedimentation prevention. Several states have legislation dealing with one or more of the above, but most of it needs strengthening in order to meet long-range social and economic requirements. Less urgent, but still important, is the need for revising and strengthening state forest protection laws. Most states have good fire protection laws and the ways and means of implementation. Likewise, most states have legislation dealing with forest pest control - insects, disease, rodents, etc., but very few provide adequate implementation. State protection laws should be amended to serve adequately all phases of forest protection including cooperative control action among forest land managing agencies and owners. Slash disposal and fire hazard abatement legislation, too, needs strengthening in Montana, Idaho, and the Pacific Coast area west of the Cascades.

Another most important part of the legislative program is the need for revising the Federal mining laws. They should be amended to eliminate conflicting, or improper, use of Federal forest and range lands. Amendments should be directed towards harmonizing public land uses for the protection of overall public interests and the protection of the miner whose intent and purpose are the legitimate mining of mineral resources. At present there is an appreciable amount of misuse of Federal lands under the guise of mining. As a result public interests are being violated and considerable damage is being done to the resources.

Land Conversion

According to the physical characteristics which determine land capability, there are 1,241,000 acres of rangeland and 1,145,000 acres

of forest land that could be used as cropland should economic and other factors permit. Conversely, there are 628,000 acres of cropland unsuited to their present use which should be put to less intensive range or forest uses.

Certain conversions would be economically feasible at present; others may never be. Some land better suited to forest is now being used for crop production or for grazing without much profit and to the detriment of the land itself. It would return profits without land deterioration if put back into forest. There are numerous small tracts of forest land totaling more than 300,000 acres that should ultimately be added to adjoining operating farm units and converted to cropland use.

Electrification and Communications

Electrification

About 95 percent of the farms in the Basin were electrified on June 30, 1952, as compared with 88.1 percent of all farms in the United States. The percentage of the electrification was highest in the State of Washington where 96.5 percent of the farms were electrified.

The use of electricity on farms in the Columbia River Basin Area is high in relation to the average use for the United States. In 1952, farms served by REA borrowers in the Basin used an average of about 5,500 kilowatt-hours annually, as compared to 2,160 kilowatt-hours for all farms in the United States served by REA borrowers. A recent study shows that farms in eastern Washington used an average of 9,845 kilowatt-hours of electricity in 1948.

The principal factor accounting for the greater use of electricity on the farm in the Columbia River Basin is the low cost power available in the area. The average cost of electricity to farm consumers of all REA borrowers in December, 1952, was 3.28 cents per kilowatt-hour as compared with 2.60 cents in Idaho, 1.73 cents in Oregon, and 1.64 cents in Washington.

About 78 percent of electricity used on farms is used in the farm homes. Studies of appliance saturation in the area indicate that four household appliances account for approximately one-half of the per farm home kilowatt-hour consumption. These appliances and the estimated number of farms using them are: refrigerator, 95 percent; electric range, 55 percent; water heater, 50 percent; and freezer, 25 percent.

From the farmer's viewpoint there are many other appliances and items of electrical equipment which, though they do not require comparable quantities of electricity for their operation, have been at least of equal importance in saving labor, reducing production costs or contributing to better rural living. In dairy and poultry types of farming areas, for example, as much as one-third of the farm usage of electricity is accounted for in conjunction with the farm enterprises.

It is estimated that irrigation pumping accounted for 8 percent of the total kilowatt-hour used on farms in 1952. Power requirement studies indicate that by 1952 the number of farms using electricity for irrigation pumping will increase fourfold, and the electric energy requirements for pump irrigation on farms will increase sixfold. This does not include the electricity required for pumping water into canals or

reservoirs.

The demand for electricity in the Pacific Northwest poses a problem which will require revision of power requirement estimates and additional plant capacity as the situation develops more clearly. Substantial capital investment will be required for system improvements to increase plant capacity to meet future demands for power.

Rural Telephony

The percentage of farms having telephones is higher in the Columbia River Basin Area than in the United States as a whole. According to the 1950 Census of Agriculture, 54 percent of the farmers in the Columbia River Basin Area have telephones, while only 38 percent of all farms nation wide have telephones. The severe winters and adverse road conditions and the scattered settlement over much of the area makes telephone service a necessity. With the exception of a few sections of the Basin Area, telephone service can be made available to farms and other rural subscribers from existing telephone companies. Consequently, no sizable number of new telephone cooperatives or independent companies is likely to develop.

CREDIT

Development of a farm, a community, a reclamation project, or a river basin area is to a large degree dependent upon, and influenced by, the amount and kinds of the credit available. If adequate credit is available, the development can proceed in an orderly, efficient manner which will be conducive to proper conservation and utilization of the natural resources. If credit is not available, development may

be hampered even though other factors are favorable. Credit, properly extended, can serve as a catalyst in bringing about resource development and improvement.

Credit Now Outstanding

The magnitude of the agricultural credit needs of the Columbia River Basin Area are illustrated by the real estate and non-real estate debt of farmers in Oregon, Washington and Idaho.

On January 1, 1953 the farm real estate debt outstanding in the 3 states was slightly over 400 million dollars. Fifty-seven percent of this amount was represented by loans of individuals or other miscellaneous lenders. The remainder was held by life insurance companies, 18 percent; cooperative Federal land bank system, 14 percent; commercial banks, 7 percent; and Federal lending agencies, 3 percent.

On January 1, 1952, the non-real estate debt of farmers reported by major lenders within the three states totaled $150,000,000. Of this amount commercial banks held 63 percent; cooperative production credit associations and other financial institutions discounting with the Federal Intermediate Credit Bank held 24 percent, and the remaining 13 percent was represented by loans of Federal loaning agencies.

No data are available showing the amount of credit extended to owners of forest lands. Until 1953 national banking associations have been prevented from loaning on timberlands under the Federal Reserve Act. Public Law 285, 83d Congress, 1st Session, amends the act to permit loans up to 40 percent of the appraised value of the economically marketable timber on managed forest tracts offered as security. However, there are definite limitations to the amendment

which make it only a partial answer to the credit problem. Loans will be for a period of 2 years only unless repaid in annual installments, in which case the loan period may be extended to 10 years.

Types of Credit Available

Private individuals account for a large proportion of the lenders in the farm mortgage field. Usually they are more liberal and less exacting than institutional lenders as to terms and purposes.

Commercial banks are of major importance in short-term credit fields. They also make available substantial amounts of credit when secured by real estate. Few restrictions are placed on the use of funds, once a credit rating is established.

Production credit associations make short-term loans for all types of agricultural purposes. These associations operate on a cooperative principle.

Life insurance companies and the Federal Land Bank system are the major institutional lenders to farmers seeking long-term loans secured by first mortgages on farm real estate. The Federal Land Bank is a cooperative.

Direct Federal farm loans are available to farm families who are unable to secure satisfactory credit at repayment terms which would enable them to finance major adjustments in their farming operations. Long-term Federal loans are available for land purchase, farm and home building and small water facility developments. Short-term operating loans are also available for purchase of machinery, livestock, and other farm operating purposes.

Credit Problems

The credit needs for cropland areas have been reasonably well satisfied except for two major needs. Adequate long-term credit for farm development and improvement in new reclamation projects is often not available until a project has been in operation for a period of years. Some of the credit needs for installation of conservation practices or purchase of foundation livestock or major farm equipment have not been met due to short repayment periods on loans not secured by farm real estate. Many farmers use their real estate as a basis for credit needed to install conservation practices or acquire livestock and equipment.

Loans by commercial banking institutions to finance the manufacture of forest products and the purchase of merchantable timber for immediate harvest are quite common, but practically no loans are made for the improvement and management of forest properties. In general, the period of amortization for loans secured by timber is so short that liquidation of the timber values is mandatory. The owner of forest land cannot borrow on the security of his timber and timberland alone at rates of interest and under terms of repayment adapted to a plan of forest management to build up growing stock and defer harvesting. Credit of the type available actually discourages good management in that no recognized value is given to immature timber. One of the major factors discouraging longer term loans on forest properties is the almost complete lack of disaster relief and insurance protection. It is very possible that adequate credit facilities will not be readily available until the lands used as collateral are protected by insurance.

As with credit, such insurance must be at rates which will encourage the management of forests for sustained production.

Credit Needs

Development of the Columbia River Basin Area will create additional demand for credit to finance the various aspects of resource development. Credit programs in new development areas, involving irrigation, drainage or land clearing, should be designed so that the operator is assured of adequate amounts of credit to permit orderly development of the resources without the necessity of exploitive use in order to live. Modification of present lending policies may be required or additional Federal funds should be made available if private sources do not or cannot meet the farm credit needs.

Credit needs for development of the agricultural, range and forestry phases of the Columbia River Basin Area are complex. Basically, they fall into 3 major categories: long-term credit for resource development such as reforestation, range improvement, and irrigation or drainage, and for farm purchase and farm buildings; intermediate-term credit for farm improvement, installation of conservation practices and purchase of foundation livestock or major farm equipment; short-term credit for annual farm operation.

Maintenance and full economic use of the land resources is of basic concern to the community, state and nation. Credit should be of such types that long-term funds are available to permit proper types of resource improvement. The soundness of credit extension in forested areas will be dependent upon proper integration of protective measures (fire, insect, disease, and rodent) and equitable taxation with the

credit extended. Federal and state credit regulations may require modification to permit private lending agencies to participate in extension of credit to resource development in the forest and rangeland areas.

The need for new sources of long-term, low-interest credit will be critical in areas where deteriorated sites and forest stands can, and should be, rehabilitated. Under present circumstances, loans are unattractive to present lending agencies. Additional research is needed to assist in development of a sound credit loan for forest and range areas.

The amount of total agricultural credit needed at any given time will depend on a number of complex, interrelated factors. For example, if the residents of the Columbia River Basin Area recognize the importance of establishing needed measures, the demand for money to invest in the capital improvements will create an accelerated demand for credit. If the economic situation of the nation is not prosperous, a greater percentage of the funds needed for developmental purposes may by necessity come from governmental agricultural lending agencies.

The social and political impact of the rapidly expanding population of the western part of the nation will have a marked effect on the demand for increased production of foods and fiber. This, in turn, will influence the rate with which the resources are developed and improved. Credit needs will therefore be intimately related to the rate and degree of development of the land and water resources.

The nations foreign relations, whether it be at peace or war, will have major influence on the credit needs of the Columbia Basin

Area, both in timing and in amount.

The present and foreseeable economic level of the nation indicates that credit needs for farm development and improvement will be on a continually expanding basis. Costs of improvement have increased to such a degree that new or younger farmers must have credit to become established or to make capital improvements in the farm plant.

Because of these complex factors no attempt has been made to predict the amount of credit needed for any one year or for total development of the Columbia Basin Area.

The benefits which will result from the proper types and adequate amounts of credit wisely extended are manifold. Farm, range and forest land owners will be enabled to develop and improve their resources in a sound manner without depletion. Income to land owners and operators will be increased. In addition, the processors and handlers of raw materials, manufacturers, transportation companies and wholesalers and retailers of consumer goods will benefit through increased business and from higher farm income. The counties, states and nation will also benefit from a more stable economy, and increased tax base, and increased profits of the producers, wholesalers and retailers.

EDUCATION

Ultimate development of the agricultural resources of the Columbia Basin Area is dependent upon the active participation of farm families, timberland owners and operators; and upon the cooperation between farm, forestry, civic and commercial organizations; local, county and state institutions; and governmental agencies. Participation and cooperation

can best be effected through complete understanding of the program, general agreement on the functions of all agencies, and the acceptance by both farm and forest people and governmental agencies of the responsibilities of each. This can be established best through educational means.

Educational Needs

General public understanding of the development proposals and appreciation of the possibilities for increased income and improved living standards are necessary. Realization that adjustments in farming, range use, and forest land management can and should be made to maintain the lands and protect public investments in new dams, reservoirs, and other structures, and insure their full and efficient use over a long period of time is important.

Educational needs are of three types: (1) to develop informed leadership and informed community organizations; (2) to assist farmers, ranchers, and forest and woodland users to understand and adopt improved and new techniques, and (3) to assist farm people to realize better living standards and farm efficiencies.

The anticipated scale of development in the program will make more acute the shortage of technically trained people to serve the various agencies and organizations that will be involved. Colleges, particularly in this area, should be aware of the unlimited opportunities such an important program affords properly trained graduates.

Educational Program

In order to contribute to meeting these and similar needs, the use of educational and service programs to be carried out with the cooper-

ation and assistance of Federal, state and local agencies and organizations is essential.

The educational program is primarily designed to work with people on the land--on private land. However, there is also need for considerable education in the proper appreciation, development and use of public lands.

Leadership and Community Organization

Definite plans must be made to inform interested or involved individuals as well as organizations with the program of development. The organized support of the public is essential to effect the ultimate program of the fullest and best interest to the area. This will involve not only rural people but in many instances urban as well. The future prosperity of the region's agriculture and forestry will greatly affect all other industry. Community development can only be achieved by the development of leadership and through adequate organizations.

New Techniques

In cropland areas, both irrigated and non-irrigated, rangeland, and forest land, education in proved methods and techniques and in latest research data must be made available.

The educational program is designed to meet the needs in three stages of development, including planning and pre-construction, development and settlement, and the post development period.

The first stage will bring to the people information on the latest research and the experience of farmers concerning the adaptability of the area, probable cost and benefits, and adjustments in farm and living situations, as well as probable market outlet. This will obviously be

of great importance in new irrigation project areas and on farms changing to irrigation.

The second will supply more detailed information on soil-and-water-management problems, water requirements of major crops, market outlets for new products, and problems of farm management and home management under different farming situations.

Educational work in the third stage of development is particularly important in order that the whole community may fully utilize the opportunities for a balanced and more stable agriculture and better living.

Educational assistance on small or individual projects, as well as on large ones, is needed. These small projects, many of which are already established, involve many of the problems inherent in major projects and have some additional problems peculiar to small enterprises. These include poor distribution systems, incomplete land development, limited supply of water, inadequate maintenance, and the need for technical services in organization, finance, legal procedures, and engineering.

Farm and forest people should always be kept abreast of improvements in varieties, management, marketing, and all other forestry, farming, and homemaking practices. This should be a constant objective.

Forest Resources

Forest resources are of great importance, the utilization of which provides for one of the leading industries of the Columbia Basin Area. The welfare of all people of the Area is greatly influenced by

the proper management and utilization of our forests.

Education of the forest land owners, both large and small, to properly manage and conserve the forests is of paramount importance. The need for better cutting practices, more adequate protection from insects, diseases, and fire must be impressed upon the timberland owner, the operator, and his employees. Education in the management of forest lands and information as to available marketing channels are of primary importance. Croplands, rangelands and woodlands are often generally intermingled and constitute inseparable parts of a complex land use pattern. Integration of woodland management with other farm enterprises is a significant need. This is particularly true when we consider that a large percent of the private commercial timberland within the Basin Area is owned as part with adjacent or intermingled cropland or rangeland.

The use of the educational approach to encourage the rehabilitation of now unproductive or partly unproductive burned-over and cut-over lands, controlling fires, insects and disease, and changing from improper cutting practices will contribute to improve the situation. The public as well as the landowners must be made aware of the necessity for such a program.

Improving Living Standards

The use of electric power in practically all rural communities has and is bringing new conveniences to farm families. Where electric power is just becoming available, particularly on new projects, families may need information on bringing water into the house, sewage disposal, electrifying the farmstead, telephones, and the selection and care of

electrical equipment.

Increased industrialization will come about as new electric power is available. Expansion of industrial centers will provide more local market outlets for farm and forest products. Equally important is that industrial expansion provides an additional outlet for employment of farm youth. Also the cost of developing and servicing improved health centers, recreational centers, and educational facilities will be shared by both rural and urban people.

Many families are receiving help in planning new houses, remodeling old ones, and reorganizing the farmstead. Home production of fruits, vegetables, and other food products provides a more adequate diet. Better health results.

Supporting Program

Of great importance is the job of supplying information concerning supporting programs of research and credit. The research program will continually make new information available. This will be disseminated through the educational program to farm and forest people and others interested as rapidly as available. Farm people will be assisted in applying research findings to their particular problems, as will owners of timberland. Educational work in relation to credit will familiarize farmers and ranchers with sound credit practices.

Educational Methods

Educational programs will be planned with rural people in their own particular areas and with representatives of agencies cooperating in the agricultural program. It is important that all available means be utilized to provide information and educational assistance to the

rural groups to be reached as well as to the public as a whole.

Very effective educational work that is fundamental and of great potential benefit is that done with the children and younger people.

Wise use of conservation information in the seventh and eighth grades in grade schools, adapting Future Farmer training in the high schools to the development program, and the organization of 4-H clubs along these lines will greatly facilitate the basin agricultural program.

Public Lands

The amount of publicly owned or managed land in the area actually exceeds that owned privately. Therefore, considerable education should be involved in understanding the problems and program for the vast area. Relatively few people understand the status of such areas with respect to ownership, responsibility, uses, and protective measures involved.

With the ever-increasing tourist travel in this area and accompanying recreational interests, greater appreciation of much of this land is resulting. This greater use is also bringing greater fire hazards to much of the timber and grasslands. Need for more and better roads is constantly increasing. The general public must be fully informed on the program for fullest economical development and use of this area in order that necessary Federal funds can be made available.

Personnel Requirements

There are now cooperatively employed with the Federal government land-grant colleges and the county governments in the Columbia River Basin Area some 405 men and women giving practically full-time to

educational programs concerned with improving agriculture and homemaking practices. This staff is fully employed with current programs. The accelerated educational program here recommended will require about 220 additional county agricultural agents, 100 home agents and 50 specialists. These additional persons will be required gradually as the program develops over a period of years.

The first specialists employed should be in technical fields which will contribute most to the irrigation and erosion control features of the program, such as agricultural engineers, soils specialists, and foresters.

Agricultural agents should first be added in counties where erosion is critical or in areas where new irrigation projects are being developed. They should be gradually added in other less critical areas where the present staff is unable to carry the accelerated load and where impacts of the various phases of the development affect the farm economy and living standards.

County home agents will be added first where new developments affect the living situation, particularly with respect to housing, use of electricity in the home, and where there are problems of living costs in relation to farm income during and following the development period. The additional staff recommended will be supervised by the present supervisory staff and housed in present county offices where possible.

Extension education as currently operated is financed largely by state and county funds with only about 30% supplied in the Columbia Basin Area from Federal sources. It seems proper that any accelerated

educational program should receive increased Federal funds comparable to appropriations to other phases of the accelerated program.

It is recommended that the Secretary be authorized to carry out with the land grant institutions in the states of Idaho, Montana, Oregon and Washington the educational program outlined herein.

Research

The soundness and rate of progress of a business, a profession, a state, a nation is to a large degree dependent upon the adequacy and proficiency of research. Research incompasses all phases of the problems, physical, economic and social. Each phase of research, to be of practical value, is interdependent upon other phases of research. For example, research findings on physical problems may have little practical value until economic or marketing research finds methods of utilization of the products of physical research. While the following sections are discussed by types of research or by land use, the whole research program is closely correlated and interdependent. The following kinds of research are considered essential to achievement of a sound land and water program for the Columbia River Basin Area.

Cropland Research

Among the many problems needing study in the irrigated sections of the Columbia Basin are the irrigation water requirements of crops, including the consumptive use of the crop as affected by climate, the effect of irrigation practices on water requirement, amount of water lost by evaporation from the land surface during and after an irrigation, the amount of precipitation that is effective in reducing irrigation requirements, canal and ditch losses and economical ways of decreasing such losses, practical methods of reducing deep percolation and surface runoff and the effect of water cost on application methods. On many of the steep rolling lands of Columbia Basin, erosion by irrigation water is excessive. The effect of size of stream, slope,

length of run, shape and spacing of furrows on different soils should be evaluated and made the basis for developing recommended practices to individual farmers.

Serious drainage problems often develop when irrigation water is applied to the land. Instruments and investigational methods should be developed in order to secure factual data relating to soil and water relationships upon which effective drainage systems may be developed. At times, drainage may be practical only through the use of wells. In other cases, tile drains or open drains are best adapted. Criteria and limitations for the use of each method of drainage should be developed and made available to technicians who are responsible for assisting farmers.

On semi-arid cropland methods of control and disposal of runoff water which traverse croplands should be evaluated. The most effective use of crop residues, terraces, diversion ditches, seeded water ways, strip crops, and crop sequence should be determined in the various soil types and rainfall area. Information is needed on the effect of shape and depth of cross section on accumulation of snow and ice during periods of alternate freezing and thawing. Retardance characteristics of the grasses used in waterways should be studied.

Information is needed on amount of deviation from contours both as to percent of slope and length in strip cropping without sacrificing effectiveness. The width of strip both for water and wind erosion needs evaluation.

Croplands west of the Cascade Mountains often require supplemental irrigation in order to insure good crops. Research on supplemental

irrigation will be similar in many respects to that for the irrigated areas. Drainage on these lands may be more generally needed than in the irrigated sections of the Basin.

Research on physical properties of soils limiting of affecting plant growth should be expanded to solve many problems arising throughout the Basin. In the irrigated areas these problems include poor aeration and low infiltration rates, excessive infiltration rates and low water holding capacities. In the semi-arid areas permeability, erodibility, aeration and water holding capacity are of particular intrest. On all soils, the effects of cropping systems, organic matter additions, type and weight of tillage equipment, soil amendments, stabilizers and drainage should be investigated with respect to these soil limitations, if found on the soil being studied. Considerable effort is warranted in developing equipment for rapid field determination of available water in the soils.

Principles and data on soil properties affecting their susceptibility to wind and water erosion are very meager. Basic research on principles will aid in solving these serious problems of land management.

The fertilizer requirements of soils requires an expanded investigation program. Particularly, research should calibrate soil or plant tissue tests with field response data so that each field of each crop can more nearly attain the economic potential production. The effects of crop sequences in the rotation, the amount and kind of water used for irrigation, the effect of land leveling, etc., on fertilizer requirements should be more intensively studied.

Investigations on removal of toxic or excessive concentrations of salts, arsenic and boron and other materials by leaching, inversion of the soil, or counteraction by chemical amendments are essential.

Evaluation of a wide range of crops and varieties of crops for various climatic zones and soil conditions existing in the Basin with regard to yield, quality, hardiness, disease and insect resistance, erosion control and windbreak effect should be expanded, particularly on new and potential reclamation projects where on-the-site information is invaluable to land development and conservation.

Programs in plant breeding, selection and introduction should be set up to broaden the choice of crops that can be grown and to produce desirable new varieties resistant to winter injury, frost damage, pests, lodging, and new strains of diseases as deficiencies in present materials become known through the adaptation and evaluation program. A wider range in maturities of processing crops is needed to extend the processing season.

Evaluation of the loss in crop yields and quality caused by insects and plant diseases, both known strains and new ones which will inevitably arise, should continue at an accelerated pace both for more adequate prediction of supplies and guidance in use of control measures. Research on control of these crop hazards should be expanded to insure high production of the individual farm and the region as a whole.

Control of the more troublesome and persistent weeds infesting many of the older Basin land and quickly invading newly reclaimed lands should be much cheaper and surer if research is expanded on control by

chemicals, cropping systems and cultural practices and combinations of these means. Quack grass, Klamath weed, bind weed, white top and Canadian thistle warrant special attention.

In the field of crop management more information is needed on time and rate of planting and seed treatments in relation to yields, disease and insect control. Special problems of pollination, insect control and chemical defoliants to facilitate harvest of legume seed for the requirements of the Basin and the rest of the country deserve increased attention.

Development of new and improved types of cultural and harvesting equipment for the special needs of Basin crops is greatly needed.

Pastures are becoming increasingly important but many questions on kinds of grasses and legumes, their rates and dates of seeding, effects of fertilizers on yields and composition, carrying capacities and management to preserve longevity and desirable species composition for different classes of livestock should be further investigated.

Evaluation of a wide range of kinds and varieties of fruits and vegetables suitable for utilization processing with regard to canning, freezing, brining, pickling and dehydration should be expanded, particularly on fruits and vegetables that can be economically produced on new and potential reclamation projects where on-the-site information is invaluable to land development and conservation.

Similarly a program of research should be conducted to evaluate the suitability for commercial processing of new kinds, strains and varieties of field crops such as alfalfa, dry beans and peas, wheat and other grain and forage crops that can be grown on either irri-

gated or dry land.

The estimated cost for initial installations of facilities is $1,181,000. Additional funds will be required to provide adequate numbers of personnel to conduct the necessary research.

Forest Research

The management of forest land for its many uses requires knowledge of the interrelations of trees, climate, and soil; of the characteristics of different tree species; of competition between trees and other plants; in total, of all the great variety of factors that affect, or are affected by forest establishment, tree growth, and the harvesting of forest crops. In this broad sense, forest management is a relatively recent development in the Columbia River Basin Area. Research to provide a sound background is equally new, and though it has gone steadily ahead, there remains much to learn.

With respect to regeneration of forests after harvesting, research is needed to learn the abundance and periodicity of seed production, the time and distance of dissemination, the losses caused by natural enemies, how to choose the right numbers and kinds of seed trees, and methods of stimulating seed production on desirable trees. With regard to stand establishment, relative rates of growth, shade tolerance, competing vegetation, and physical and biotic injuries are factors which must be studied thoroughly. It is necessary to learn how properties of the soil affect trees, how the trees modify them, and what forest practices such as thinning and logging do to the soil. It is also necessary that we understand the specific effects of rain, solar energy, wind, snow, freezing, relative humidity, and their effects on

on the natural distribution of trees.

There are significant possibilities of increasing forest productiveness by identifying or developing superior tree strains better able to resist parasites, grow faster, and in other ways excel run-of-the-woods trees. Research in improvement of trees by breeding will necessitate studies of characteristics such as faster growth and how these are transmitted; how superior trees can be recognized, evaluated and propagated; systematic search for superior trees, hybridizing, and field testing. A full-scale program of genetics research for the Columbia Basin should include development of improved seed procurement methods through the preparation of collection standards, the registry of seed collection areas, and of outstanding trees; critical evaluation of apparently superior stands and trees; studies in seed orchard technology, including methods of propagation; improvement of existing species through the controlled pollination of trees outstanding in growth rate, form, wood quality, or resistance to damaging agents; and development of hybrids.

Tree physiology and the mechanics of growth processes need increased attention. Application of knowledge of a single tree or species can then be extended to the forest through silvicultural research. Silvicultural problems include the conversion of overmature timber stands into growing managed forests, restocking of burned and cutover lands now covered with unproductive brush, thinning young timber stands to reduce mortality and increase growth, and pruning to improve timber quality. Research is needed on all of these problems.

With changes in forest management and in forest products, utilization needs for improved measurements of forest trees have developed.

Refined methods of determining tree volumes and growth rates, and development of new volume tables for young-growth trees and for species becoming commercially important are increasingly needed.

Applied forest management research is needed to test in pilot commercial-scale operations the conclusions reached by basic small-scale studies. In most cases, cost records will be of prime importance. These studies would involve logging plans, logging methods, slash disposal, and water quality protection.

Research is needed in forest products utilization, to find new uses for secondary forest trees and to reach more complete utilization of the timber resource. This research would include development of uses for material now wasted, both in the forest and in the mill. It would also include reduction of losses from improper seasoning, insect attack, and rot.

Research in watershed management is needed to cover problems of water quantity and water quality. It would involve basic studies of evapotranspiration losses, and watershed studies of the effects of the timber harvest and other operations on water supply. It would provide specifications for control of operations to safeguard water quality and to ensure favorable seasonal distribution of water yields.

Fire is a constant threat to the forest. Although fire control has become highly effective, blow-ups are an ever-present possibility. Research is needed to develop improved fire prevention programs, to explore possibilities of preventing lightning fires through weather modification techniques, to develop better fire-fighting tools and methods. Research is needed to determine the effects of fire on soil

and watershed values, and to find the best means of using fire as a tool in forest management.

Other phases of forest research dealing with soils, climate, pest and diseases, economics, and insurance and credit are dealt with in other sections of this report. The total cost estimated for all phases of the needed forest research program amounts to $4,800,000 for initial investment, and $2,000,000 annually thereafter for the entire Basin Area. The necessary research work could be carried on by the Federal, state, and private agencies which are currently engaged in this type of research.

Rangeland Research

The fundamental needs for research on rangelands are:

1. Ecological studies of the important range plants correlated with determinations of plant populations and trends for the important species under various intensities of grazing use, and ecological studies of the principal range forage types as related to moisture, supplies, soil and climate.

2. Detailed studies of species and areas of adaptation for seeded forage plants, determination of the chemical composition of the principal grazing species at their several recognized stages of grazing use, and forage preferences shown for the different classes of domestic livestock, deer and elk.

3. Watershed studies to determine the rate of absorption of precipitation for the important forage types and range conditions. Hydrologic studies should also be correlated with slope, cover, soils and temperatures.

4. Methods to control insect infestation and plant diseases, methods to control seed eating and forage consuming rodents, and evaluation of the effects of trampling by game animals and livestock and of the burrowings and ground workings by rodents and insects on rangeland areas. Range losses due to insects and diseases exceed a million dollars annually.

5. Special attention should be given to soil stabilization measures, water control and water impounding practices; soil-water and plant-water relations as related to the amount and kind of plant residue, vegetal composition, soil moisture losses, etc.

6. The need for detailed behavior studies of range fires is very great. This information and data for rangelands are essential for the developments of effective fire control and prevention measures to reduce the annual losses running into millions of dollars.

7. Wider and more detailed knowledge and information is needed to properly plan the grazing use of forage and hay crops now being plowed down as green manure crops in the higher rainfall wet areas.

8. Carefully determined tests and surveys are greatly needed to determine what methods might be used to secure better rotational use of ranges and pastures, and thus secure more effective year-long feed balances for various size ranches and determinations of the economical size for range units.

It is estimated that the needed range research program, such as is briefly outlined here, could be accomplished by the expenditure of $1,500,000 annually for personnel and current operating expenses during a 10-year period. Approximately $14,000,000 is needed for capitol

investment in lands, buildings and heavy equipment for the 10-year period.

Research Involving More Than One Type of Land

Certain resources of the Columbia River Basin Area, such as water and wildlife, certain uses such as recreation, and certain problems such as provided by fire and climate are derived from or may affect any class of land. A large part of the Basin Area, while producing crops or forage or timber, also produces water. Some of this land is primarily valuable as a source of water supply; and it is essential that land management for these other purposes be compatible with good water management. The tendency has been to adhere to single-purpose management because of a lack of adequate guides to multi-purpose management. Comprehensive management requires information that must be furnished by research.

Needs in this field include such things as studies of the relative efficiency of different types of vegetation as watershed cover and in soil stabilization, studies of effects of logging and grazing on water yield and water quality for the widely varying conditions of the area, development of modifications in land use practices that will reduce soil disturbance to a safe minimum, development of techniques and methods to improve the soil and rehabilitate areas where extensive site deterioration has occurred, and the determination of plant species best suited to soil stabilization and erosion control over a wide range of conditions. Control of fire on forest and rangelands demands more knowledge of fuel types and fire behavior. Fire as a useful tool in certain phases of forest and range management needs to be thoroughly

tested and evaluated. The effects on game animals of operations on the land need to be determined and evaluated.

Determination of best land use requires information on the potential productivity of land in various categories to furnish sound criteria. More detailed knowledge is needed of climatic factors and the use of shelterbelts to protect crops and increase yields. Investigation of the applicability and utility of cloud-seeding to modify water supplies must be continued.

Of concern to all phases of research is the method of collection and analysis of data. New problems often demand new solutions, and old problems call for better solutions. The patterns of scientific inquiry need constant refinement. Techniques applicable in one case must be changed to be used elsewhere. Continued study in the field of research methods for sampling, measurement, and analysis is necessary to eliminate bias and insure adequate results.

<u>Economic Research</u>

The proposed land treatment and land use program will require farm and ranch operators to assume certain costs. To assist the operators in making decisions, research is needed in the economics of conservation to determine the effect of various practices or combination of practices, capital requirements, labor requirements, land use and returns.

Credit has not been readily available to either forest owners or settlers on new irrigation projects. In both cases, research is needed to determine credit requirements which will enable the operator to develop an economic unit and ways the credit needs can be satisfied. Research is also needed in established farming areas to determine the

limits of efficient combinations of capital and labor and availability of credit to finance adjustments.

Closely allied with credit is the need for insurance to protect the forest owner from losses arising from major risks. Research is needed to develop a feasible insurance program for forest land.

The high capital requirements have made the acquisition of an efficient farm unit more difficult, and research is needed to analyze the problems involved in acquiring initial ownership of farm or ranch land, to analyze the problems associated with the acquisition of additional land, and to evaluate economically the tenure process. For rangelands, research is needed to determine the relationship of size, pattern, and type of ownership to intensity and kind of management. Also for range, there is need for research to analyze the effects of various land costs on range management. For forest lands, research is needed in tenure to determine the pattern of land ownership and the manner in which owners exercise and control their ownership rights.

Land managers are constantly faced with meeting many uncertainties, and research is needed which will enable the operator to adjust his operations to the uncertainties arising from disease, pests, weather and other physical factors, from technological advancements, and from changes in price relationships.

No matter whether a manager operates crop, range, or forest land or a combination of these, he is concerned with attaining an economic unit. To assist him, research is needed to determine the best combinations of factors of production. In case of a farm, research is also needed to determine the best combinations of enterprises.

The development of irrigated land has become increasingly costly, and considerable economic research work is needed to guide sound development. Research is needed to determine what lands are physically and economically feasible for irrigation, to analyze the economics of sprinkler, and to appraise the rate of settlement progress.

In farming areas characterized by long rainfall cycles, research is needed to determine the economic limits of a farming economy based entirely on range, entirely on wheat, or on a combination of the two, and to determine the extent to which land use does or should change.

The agricultural economy of the area is dependent upon an efficient marketing system which assembles, processes and moves agricultural products to areas of consumption. Research is needed to determine the local, secondary, and aggregate flow of agricultural products, and to assist in the development of efficient marketing channels. For forestry, this would require a study of the entire distribution system of forest products and an analysis of how the different segments of the system are related.

The increase in population has a significant effect on the use of land. Research is needed to determine the relationship between intensity of land use and size of operating unit, tenure, type of use, land values, and other similar factors and to determine how these shifts in intensity of use can be accomplished with the least interruption.

The competition between big game and livestock and between livestock for the use of range resources is particularly acute in some areas. Research is needed to determine the relative benefits

derived from big game and livestock production and ways to obtain desirable adjustments in areas where big game and livestock compete for the available forage. In areas where there is a lack of balance in seasonal range use, research is needed to determine the effect of this lack of imbalance on the use of the range.

Forest resources, in particular, must be protected against damage by fire, insects and disease. Research is needed to determine the cost involved and to analyze the benefits which will arise from protection.

Research is needed in technological innovations to determine the effects of the adoption of the innovations and to determine the actual cost nature of the technological innovations.

Fluctuations in the economic cycle affect the conservation and development of our basic resources. Research is needed to determine how variations in the economic cycle influence the nature, extent, and timing of the conservation, development and use of our basic resources.

Full use of research findings require that there be a knowledge of the economic development which is likely to take place in the area in the near future, and research is needed to determine the extent of growth and development in the Columbia River Basin Area, to analyze the balance of payments in the area, and to classify economic activities of the area. Research is also needed to analyze changes in population consumption habits.

Many indirect benefits accrue to the economy because of the development and improvement of our basic resources. Research is needed to appraise these indirect benefits and the effect of these benefits on the cultural growth of the area.

The role of Federal, state, and local governments in the conservation, development, and utilization of our resources has increased.

Research is needed to determine the effects of government policies on income stability, distribution of income in agriculture, and distribution of income between agriculture and the other segments of the economy and to determine the effects of governmental policies on resource development and utilization.

Currently state and Federal agencies are spending approximately $317,000 annually for economic research work of the type outlined. It is estimated that an additional $504,000 annually is needed to do the entire job. The sum of $50,000 is needed in the first year for capital investments to initiate some projects.

Weed, Pest, and Disease Research

Weed control is important to agriculture, as weeds cause reductions in crop yields and weed seeds contaminate harvested crops. Poisonous plants cause losses of livestock on the range as well as reducing the growth of good forage. Control of the more troublesome and persistent weeds infesting many cropland and rangeland areas could be made cheaper and surer by means of research to improve present control methods. Such plants as quackgrass, Klamath weed, bindweed, whitetop and Canadian thistle warrant special attention on croplands, and the poisonous halogeton and larkspur on rangelands. Surveys to determine extent and density of weed infestations, and evaluation of control and eradication measures represent a continuing need. As agricultural development increases, weed problems become intensified; research is needed to find effective specific herbicides and to develop systems of control through tillage and other cultural practices.

Allied to the weed problem is that of the unpalatable sagebrush and rabbitbrush that crowds out good forage plants on rangeland, and

that of the brushfields that have invaded burned and cut-over forest lands. As with the herbaceous weeds, research is needed on the life histories and ecology of these plants as a basis for intelligent application of control measures as well as on agents and cultural practices for control.

Insect pests attack growing crops and stored farm products, range forage plants, forest trees, and livestock, causing tremendous losses. Insects are said to harvest more timber each year than the lumbermen. The first control step is prevention; it is dependent upon knowledge of factors that cause sudden and widespread epidemic build-ups. Regular surveys are needed to measure extent of insect infestations and to detect incipient outbreaks. Research is needed to discover and test possible indicators of insect outbreaks, to furnish additional information on the habits and environments of various insect species, and to develop and test insect-control materials and techniques. Specific attention must be given to such forest enemies as the Engelmann spruce beetle, the Douglas-fir beetle, the western pine beetle, the spruce budworm, and the western hemlock looper. Also in need of immediate attention are such range pests as grasshoppers, crickets, tent caterpillars, and the Pacific grass bug; and such cropland pests as nematodes, clover seed beetles, pea aphids, the granary weevil, the rice weevil, and the lesser grain borer.

Rodent pests cause damage of various kinds, and are responsible for heavy losses. While adequate control programs have been developed for some species, considerable research is needed on methods of control of rodent populations, on the life histories and environments, and on

determining extent and significance of rodent damage. Specific attention needs to be given to developing effective and economic means of reducing timber damage by porcupines and seed destruction by chipmunks and mice in forest areas, mouse and gopher and ground squirrel damage to range forage, and rat and mouse damage to stored farm products.

Research is needed on numerous plant diseases that provide serious threats to agriculture and forestry. Important diseases about which more needs to be known, and for which adequate controls must be developed, include potato scab, verticillium wilt, several smuts and rusts and root rots on croplands and rangelands, the pole blight and blister rust of white pine and various root rots on forest lands. Losses to plant diseases must be evaluated, new diseases must be identified, soil fumigants and sterilants must be developed and tested, and means of controlling disease through cultural practices must be worked out. Relationships of present use and management practices to plant diseases needs to be determined. No positive control programs can be undertaken until research has shown the way.

Surveys

Surveys are required to accurately catalog or inventory the physical resources of an area. An accurate inventory of the resources is basic to proper planning for and utilization of these resources. The following types of surveys are deemed of primary importance in sound, progressive development of the Columbia River Basin Area.

Soil and Erosion Surveys

An accurate knowledge of the soils - their nature, distribution, location, behavior, suitability for use, management requirements, and productivity - is essential to attain a high level of use, development, and conservation of the land and water resources of the Basin Area.

Soil surveys are designed to determine the characteristics of soils, to classify soils into defined types and other classificational units, to establish and plot on maps the boundaries among kinds of soils, and to predict the suitability of soils to various crops, grasses, trees, or other uses, their behavior under different use and management systems, and the yields of adapted plants under specified management practices.

Soil surveys are used in many ways, but perhaps their fundamental purpose is to secure information upon which to make sound predictions about soils and their behavior, which can be applied in agriculture, including forestry and grazing, and certain engineering problems. Soil surveys are a necessary part of an effective soil research and advisory program. Besides serving as a geographic frame of reference in the planning of field, forest, and laboratory research, soil maps and reports serve as a basis for classifying, synthesizing, and

reporting the results of research and experience on soils and their behavior and the extension of this information to other areas.

The kind and intensity of the soil surveys needed depends upon the land use. The major kinds of land use in order of decreasing intensity needs, together with acreages needing adequate detailed soil surveys, are as follows: (1) irrigated lands and new irrigated projects, 5,898,000 acres; (2) non-irrigated cropland areas, 6,774,000 acres; (3) forest areas, 23,745,000 acres; (4) non-forested range, 55,177,000 acres, and (5) other land, 6,632,000 acres. The acreage for which detailed soil surveys are needed totals 108,226,000 acres.

Erosion surveys can be made an integral part of the soil survey. Information needed includes the kind, location and degree of soil erosion over larger areas. Such a survey will furnish information on the present rate of erosion, the susceptibility of various soils to erosion and the effects of erosion on kinds of soil. Erosion information, in addition to that ordinarily obtained in a detailed soil survey, is needed on the following: stream bank erosion and sheet, gully and wind erosion.

Water Supply Surveys

Data on peak and seasonal flows of small streams, those ranging from less than a square mile to about 20 square miles in size of drainage area, are particularly needed in agricultural areas throughout the Basin Area for the design of flood control, drainage, and irrigation works. Peak flow data are needed for the design of such structures as gully control dams, culverts, channels, diversions and outlets.

This same sort of data is needed by the Forest Service and State and County highway engineers for the design of culverts and small bridges. Data on seasonal flow on small streams are needed for the design of drainage systems and irrigation storage reservoirs and systems. It is estimated that a total of 2,225 crest stream gages and 524 recording stream gaging stations is needed on small streams.

Snow surveys form the basis for prediting seasonal stream flow. Surveys of about 170 new snow courses are needed. Surveys on present courses should be intensified.

Water storage surveys include groundwater surveys and observations, reconnaissance surveys and inventories of potential reservoir sites on small streams. Underground storage basins will be drawn on for irrigation, municipal, industrial, and domestic water, as the area is developed. Groundwater observations should be started as soon as groundwater use is developed, to determine safe water yield and prevent economic hardship that could be caused by over-development and water depletion.

Relatively few surveys have been made of potential sites for smallreservoirs on small streams and exploration and development of groundwater reservoirs. Reconnaissance surveys are needed on 58,000 square miles of the Basin Area. Detailed studies should be made of portions of the area as development proceeds and the need for more detailed information arises.

Almost every year at several points in the Columbia River Basin Area, extraordinary floods occur. Flood damage surveys are needed to obtain information on agricultural and land damages of floods when

they occur. This sort of information is necessary in the formulation of policies and programs of assistance to farmers in such areas. The estimated cost of providing the needed program of water supply surveys in the Columbia Basin Area in the next 20 years is $12,258,000.

Climatic Surveys

Precipitation, temperature, and other climatic data are especially lacking in unsettled areas and at the higher altitudes in parts of the Basin Area. Sampling is inadequate, and often misleading, where extreme differences are caused by marked topographic or other disturbances. More evaporation data are needed at well-chosen stations.

Additional climatic observation stations are needed in the Basin Area to improve coverate in the hydrometeorological network, improve flood warning services, improve operation of dams for flood control, irrigation, or power development, determine frost-hazard areas, and to improve soil management practices. The number and types of climatic stations needed to supply this information are as follows: 362 standard and 188 recording precipitation stations, 245 temperature stations and 10 evaporation stations.

Other Basic Surveys Including Cadastral

In order to adequately manage the land and related resources and to expeditiously carry out a program as outlined, landowners and operators must have at their disposal accurate, up-to-date basic survey data and maps. Included in this item are basic aerial surveys and maps, General Land Office surveys and maps, land line surveys, general area surveys, and related cadastral surveys.

The greatest need for this type of information is in the remote,

relatively undeveloped portions of the Basin. Consequently much of the needed work is on lands in public ownership. More than one type of survey and map will be required for many specific areas. In the aggregate a total of 234,000 square miles of survey and map work are required.

Forest Resource Inventory

This project is designed to obtain initial information for, and keeping current at specified standards, a comprehensive survey of forest resources of the Columbia Basin Area. The subject matter includes an inventory of timber resource by species, type, stand-size class, and ownership, in terms of volume and area; annual growth and annual drain by species group, broad ownership class, and stand-size class; annual mortality by cause, species group, and stand-size class; and pertinent related information on use and need of forest products by major segments of the forest products industry. Forest site information and growth data will be obtained with a sufficient degree of refinement to compute the potential timber volume and yield under various conditions of management, and existing or proposed forest land programs. Interpretation and analysis of the data will be made for critical local areas. Resurveys will be made in the field at from 10 to 15 year intervals.

This information is widely used by all levels of government as background for policy decisions on legislation in the field of forestry. It is used, and needed, by forest landowners and forest land managers, and by local community organizations such as chambers of commerce, in appraising the forest situation of their locality and in deciding on

long-term actions they should take to better their particular interests.

The initial project cost is estimated to be $1,263,000, primarily Federal. State and local contributions to the work can be expected, however.

Range Resource Inventory

This project is designed to obtain information for, and keeping current at specified standards, a comprehensive survey of the range resources of the Columbia Basin Area. Subject matter includes an inventory of range resource by species, type, ownership, condition and density in terms of grazing capacities and areas; range condition trends by species, types and broad ownership classes; range use by types, location and ownership groups; and pertinent related information on use and need of range resource by domestic stock and game animals. Range site information and similar data will be obtained to compute potential use and grazing capacities under various conditions of management, and existing or proposed rangeland programs. Interpretation and analysis of the data will be made for critical local areas. Resurveys will be made in the field at about 10-year intervals.

This information is needed by all levels of government as background for policy decisions on legislation. It is needed and would be used by rangeland owners and managers, and by local community organizations, in appraising the range situation in their localities and in deciding on long-term actions which should be taken to improve their particular interests.